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No. 14

In this issue

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ABSTRACT

Energy-intensive industrialization in the Middle East

Thomas R. Stauffer

The study examines prospects for further energy-intensive industrialization in the oil-exporting countries of the Middle East, with particular reference to the major oil exporters of the Gulf. It covers the following matters: background of industrial development strategies and objectives in the Middle East; assessment of opportunity cost of capital and the implications of capital availability for both low- and high-absorbing oil-exporting countries; availability and evaluation of natural gas; structure of value-added in energy-intensive sectors, measures of potential profitability and relative economic ranking of various industrial options; and complementarities with developing countries, opportunities for co-operation and areas of potential competition. It concludes that the potential comparative advantage of oil-exporting countries in heavy industry, in particular those industrial sectors which are either capital or energy-intensive, is very real. Their potential has been largely based on an absolute advantage resulting from an abundant supply of cheap gas. However, the scope for accelerated development of large new industry in the Gulf is considerably limited by the likely future availability of gas, since for most oil-exporting countries, associated gas, once a free good, is now in tight supply. Moreover, whereas industrialization in the Gulf creates some complementarities with the rest of the third world, it also generates new intra-third-world competition.

Financial reconstruction for North-South and South-South trade

Amit Bhaduri

This article describes how the present system of international finance hinders trade expansion and economic growth, especially in countries with large debts and soft currencies, most of which are developing countries. Agreement on comprehensive reform of the system seems unlikely in the foreseeable future. Financial co-operation among developing countries could start, however, with the following two steps: settlement of intra-South trade deficits in local currencies; and floating of a common southern placement currency on the principle of limited liability of participant countries. The article discusses why and how this should be done.

Trends in United States manufacturing industry and their possible implications for Latin American industrialization: case-studies of steel, electronics and petrochemicals

Peter B. Evans

This study considers developments in United States industry, particularly the three major branches of steel, electronics and petrochemicals, and possible implications for these industries of shifts in United States government policy. It then examines how these same industries in Latin America might be affected. The following shifts in policy are considered: active retardation of structural change; positive adjustments to achieve increased competitiveness in international markets; and

"internationalist accelerated adjustment", by which is meant that policy would be strongly influenced by the need to avoid disrupting growth in other nations. In the United States the three above-mentioned industries are respectively marked by decline, rapid growth and an uncertain future. The author concludes that prospects for positive United States adjustment policies are not encouraging, and that protectionist pressures might spread to industries whose competitive position has been traditionally strong, such as petrochemicals. Moreover, he finds no convincing evidence that United States transnational corporations will provide support for Latin American manufacturing sectors in conflicts with United States domestic interests. Even in electronics, prospects for growing Latin American participation appear very limited.

The potential for South-South trade, particularly in capital goods industries

Jeffrey Nugent

In this article the following criteria for assessing the potential for trade among developing countries are proposed: production should be intensive in the use of factors which, although not available in sufficient quantities in any single developing country, are sufficiently available in the South as a whole; growth rates of both production and exports by the South should be above average; and production should be characterized by significant learning-by-doing effects, rather than by high rates of new product development. Industries meeting these criteria are identified, and, in particular, most capital goods industries are considered especially promising. Further arguments for the development of the capital goods industry in the South are presented. Obstacles to such development and the means of overcoming them are discussed. The recent experience of the South in capital goods production and trade is examined with a view to determining the potential for developing the capital goods sector on the basis of South-South co-operation.

SOMMAIRE

L'industrialisation à forte intensité d'énergie dans le Moyen-Orient

Thomas R. Stauffer

L'auteur envisage les perspectives d'industrialisation à forte intensité d'énergie dans les pays exportateurs de pétrole du Moyen-Orient, et particulièrement dans les principaux pays exportateurs de la région du Golfe. L'étude traite des sujets suivants : fondement des stratégies et des objectifs de développement industriel dans le Moyen-Orient; estimation du coût des investissements en faveur du développement et conséquences des disponibilités de capitaux pour les pays exportateurs de pétrole à faible et à forte consommation d'énergie; ressources en gaz naturel disponibles et leur évaluation; structure de la valeur ajoutée dans les secteurs à forte intensité d'énergie, mesure de la rentabilité possible et classification par ordre d'importance économique relative de diverses options industrielles; complémentarité avec les pays en développement, possibilités de coopération et secteurs de concurrence éventuelle. L'auteur conclut en constatant que l'industrie lourde présente de très réels avantages pour les pays exportateurs de pétrole, particulièrement dans les secteurs industriels à forte intensité de capital ou à forte intensité d'énergie. Jusqu'ici, les possibilités de ces pays se fondaient en grande partie sur l'avantage absolu que leur conféraient des ressources abondantes de pétrole bon marché. Toutefois, les perspectives d'établissement de grandes industries nouvelles dans la région du Golfe sont très limitées car, dans la majorité des pays pétroliers où l'essence était autrefois une marchandise gratuite, la fourniture de celle-ci est aujourd'hui moins libérale en raison de restrictions d'approvisionnement qui risquent encore de s'aggraver. De plus, s'il est vrai que l'industrialisation de la région du Golfe crée certaines complémentarités utiles avec le reste du tiers monde, elle crée aussi une concurrence nouvelle à l'intérieur du tiers monde.

Restructuration financière des échanges commerciaux Nord-Sud et Sud-Sud

Amit Bhaduri

L'auteur explique comment le système financier international entrave actuellement l'expansion des échanges commerciaux et le développement économique, en particulier dans les pays très endettés et à monnaie faible, qui sont pour la plupart des pays en développement. Un accord sur une réforme profonde du système paraît aujourd'hui peu probable dans un avenir prévisible. Pourtant, une coopération financière entre pays en développement serait souhaitable et pourrait s'instituer par le biais des deux mesures suivantes : règlement en monnaies locales des déficits commerciaux entre pays du Sud et institution d'une monnaie fiduciaire commune servant aux placements dans les pays du Sud et reposant sur le principe de la responsabilité limitée des pays participants. L'auteur expose les raisons pour lesquelles un tel système devrait être institué et les modalités de sa mise en place.

Tendances de la politique industrielle des Etats-Unis et leurs conséquences possibles pour l'industrialisation de l'Amérique latine : études de cas sur l'acier, l'électronique et la pétrochimie

Peter B. Evans

L'auteur examine l'évolution industrielle aux Etats-Unis, dans trois branches importantes : l'acier, l'électronique et la pétrochimie, ainsi que les répercussions que certaines modifications de la politique du Gouvernement des Etats-Unis pourraient avoir sur ces industries. L'auteur examine ensuite comment ces mêmes industries, en Amérique latine, pourraient s'en trouver atteintes. Il envisage les changements de politique suivants : temporisation délibérée en ce qui concerne les modifications structurelles, ajustements positifs pour accroître la compétitivité sur les marchés internationaux, et adaptation "multinationaliste" accélérée, cette stratégie s'inspirant de la volonté d'éviter toute perturbation de la croissance d'autres pays. Aux Etats-Unis, les trois domaines industriels susmentionnés sont respectivement marqués l'un par le déclin, l'autre par une croissance rapide et le troisième par des perspectives d'avenir peu sûres. L'auteur estime que les perspectives de changements positifs de la politique des Etats-Unis dans ce domaine ne sont pas encourageantes et que des pressions protectionnistes pourraient s'étendre à certaines industries dont la position sur le marché est traditionnellement forte, comme c'est le cas pour la pétrochimie. D'autre part, il n'est pas convaincu que les sociétés transnationales américaines acceptent d'appuyer des secteurs industriels d'Amérique latine dont les intérêts seraient en conflit avec les intérêts internes des Etats-Unis. Même dans le secteur de l'électronique, les perspectives d'une participation accrue de l'Amérique latine paraissent très limitées.

Perspectives d'échanges commerciaux Sud-Sud, notamment dans le secteur des industries de biens d'équipement

Jeffrey Nugent

Dans cet article, l'auteur propose les critères suivants pour évaluer les possibilités d'échanges commerciaux entre pays en développement : la production devrait recourir essentiellement à des facteurs de production qui, sans être disponibles en suffisance dans chacun des pays en développement, le sont cependant dans l'ensemble de la région Sud; les taux de croissance de la production et des exportations de la région Sud devraient être supérieurs à la moyenne; la production devrait se caractériser par une assimilation spontanée et directe du savoir-faire, plutôt que par la mise au point très poussée de nouveaux produits. L'auteur précise quelles sont les industries qui répondent à ces critères; ce sont en particulier la plupart des industries de biens d'équipement qui paraissent les plus prometteuses. L'auteur présente divers arguments en faveur du développement de l'industrie des biens d'équipement dans le Sud. Il indique les obstacles qui entravent ce développement et les moyens de les surmonter. Il analyse ce que la région Sud a fait récemment dans le domaine de la production et du commerce des biens d'équipement, en vue de déterminer les possibilités de développement de ce secteur industriel sur la base d'une coopération Sud-Sud.

EXTRACTO

Industrialización con uso intensivo de energía en el Oriente Medio

Thomas R. Stauffer

El estudio considera las posibilidades de una mayor industrialización con uso intensivo de energía en los países exportadores de petróleo del Oriente Medio, refiriéndose especialmente a los principales países petroleros del Golfo. Incluye los puntos siguientes: consideración general de las estrategias y objetivos del desarrollo industrial en el Oriente Medio; evaluación del costo de oportunidad del capital y consecuencias que la disponibilidad de capital tiene para los países exportadores de petróleo con bajo y alto poder de absorción; disponibilidad y evaluación de gas natural; estructura del valor añadido en los sectores con uso intensivo de energía, medidas de rentabilidad potencial y clasificación económica de diversas opciones industriales; y complementariedades con los países en desarrollo, oportunidades de cooperación y sectores de posible competencia. Llega a la conclusión de que la ventaja relativa potencial de los países exportadores de petróleo en la esfera de la industria pesada, particularmente en los sectores industriales con un uso intensivo de capital o de energía, queda plenamente confirmada. La potencialidad de estos países se ha basado principalmente en la ventaja absoluta que resulta de la abundante disponibilidad de gas barato. No obstante, la perspectiva de un desarrollo acelerado de una gran industria nueva en el Golfo se ve considerablemente limitada por las previsiones sobre disponibilidad futura de gas, ya que en la mayoría de los países exportadores de petróleo, el gas asociado a él, del que se disfrutó en un tiempo sin restricción, es suministrado ahora con parsimonia. Además, si bien la industrialización genera en el Golfo algunas complementariedades con el resto del tercer mundo, también da lugar a una nueva competencia dentro del tercer mundo.

Reconstrucción financiera para el comercio Norte-Sur y Sur-Sur

Amit Bhaduri

Este artículo explica cómo el actual sistema financiero internacional dificulta la expansión comercial y el crecimiento económico, especialmente en los países con gran endeudamiento y una moneda blanda, la mayoría de los cuales son países en desarrollo. En un futuro previsible no parece probable un acuerdo sobre una reforma global del sistema. La cooperación financiera entre los países en desarrollo podría iniciarse, no obstante, con los dos pasos siguientes: liquidación de los déficits comerciales dentro del Sur en monedas locales; y flotación de una moneda común de inversión del Sur basada en el principio de la responsabilidad limitada de los países participantes. El artículo analiza los argumentos a favor de estas medidas y la manera de introducirlas.

Tendencias en la industria manufacturera de los Estados Unidos y sus posibles consecuencias para la industrialización latinoamericana: estudios de casos sobre el acero, la electrónica y la petroquímica

Peter B. Evans

Este estudio examina la evolución de la industria de los Estados Unidos, en especial de las tres ramas principales del acero, la electrónica y la petroquímica, y las posibles consecuencias que un cambio en la política gubernamental de los Estados Unidos podría tener para estas industrias. Se considera después cómo podrían quedar afectadas estas mismas industrias en América Latina. Se toman en cuenta los siguientes cambios de política: postergación activa del cambio estructural; ajustes positivos para lograr una mayor competitividad en los mercados internacionales; y "ajuste acelerado internacionalista", que significa que las decisiones estarían muy condicionadas por la necesidad de evitar un crecimiento perturbador en otros países. En los Estados Unidos las tres industrias mencionadas se encuentran, respectivamente, en decadencia, en rápido crecimiento y con un futuro incierto. El autor concluye que no hay perspectivas alentadoras en el sentido de unos ajustes positivos en los Estados Unidos, y que las presiones proteccionistas podrían extenderse a aquellas industrias cuya posición competitiva ha sido tradicionalmente fuerte, como es el caso de la petroquímica. Además, no encuentra razones convincentes para pensar que las empresas transnacionales de los Estados Unidos vayan a apoyar a los sectores manufactureros latinoamericanos que se encuentren en conflicto con los intereses nacionales de los Estados Unidos. Aún en el caso de la electrónica, las posibilidades de una mayor participación latinoamericana parecen muy limitadas.

Las posibilidades del comercio Sur-Sur, especialmente en las industrias de bienes de capital

Jeffrey Nugent

En este artículo se proponen los siguientes criterios para evaluar las posibilidades del comercio entre países en desarrollo: la producción debe utilizar intensivamente factores que, aunque no existan en cantidad suficiente en cada país en desarrollo por separado, existan en suficiente cantidad en el conjunto del Sur; las tasas de crecimiento del Sur, tanto de la producción como de las exportaciones deben ser superiores al promedio; y la producción debe caracterizarse más por unos efectos significativos del aprendizaje en la práctica que por unas altas tasas de desarrollo de nuevos productos. Se identifican las industrias que cumplen estos criterios y, en forma particular, las industrias de bienes de capital se consideran especialmente prometedoras. Se exponen otros argumentos en favor del desarrollo de la industria de bienes de capital en el Sur. Se analizan los obstáculos para este desarrollo y los medios de superarlos. Se examina la experiencia reciente del Sur en la producción y comercio de bienes de capital con el fin de determinar qué posibilidades de desarrollo tiene el sector de los bienes de capital, sobre la base de la cooperación Sur-Sur.

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AIMS AND SCOPE OF *INDUSTRY AND DEVELOPMENT*

Industry and Development attempts to provide a link between practitioners and theorists working on economic and related aspects of industrialization. The focus of the journal is on applied economics, particularly in areas emphasized in the Lima Declaration and Plan of Action on Industrial Development and Co-operation.

The journal is published an average of four times a year as an integral part of the work programme of the Division for Industrial Studies of the United Nations Industrial Development Organization. It is prepared under the general guidance of a Supervisory Panel, composed of staff members from the Division, with the Head of the Global and Conceptual Studies Branch as its chairman. Responsibility for the detailed supervision of a specific issue is rotated among the members of the Panel. The responsible member for this issue was J. Cody.

The Supervisory Panel of *Industry and Development* welcomes readers' opinions and comments.

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Explanatory notes

References to dollars ($) are to United States dollars, unless otherwise indicated.

The following abbreviations are used in this publication:

EEC	European Economic Community
GNP	gross national product
HDPE	high-density polyethylene
IBRD	International Bank for Reconstruction and Development
ISIC	International Standard Industrial Classification
LDPE	low-density polyethylene
MITI	Ministry of International Trade and Industry (Japan)
NICs	newly industrializing countries
OECD	Organization for Economic Co-operation and Development
OMA	orderly market agreements
OAPEC	Organization of Arab Petroleum Exporting Countries
OPEC	Organization of Petroleum Exporting Countries
PVC	polyvinyl chloride
RAM	random access memory
ROI	return on investment
SABIC	Saudi Basic Industries Corporation
SIC	Standard Industrial Classification (United States)
TNC	transnational corporation
TPM	trigger price mechanism
UNIDO	United Nations Industrial Development Organization
USITC	United States International Trade Commission
USWA	United Steelworkers of America
VHSIC	very-high-speed integrated circuit
VLSIC	very-large-scale integrated circuit
VRA	voluntary restraint agreement

ENERGY-INTENSIVE INDUSTRIALIZATION IN THE MIDDLE EAST

Thomas R. Stauffer*

In this paper the prospects for further energy-intensive industrialization in the oil-exporting countries of the Middle East are considered, with particular reference to the major oil exporters of the Gulf and to the possible implications for other countries of the third world.

The long-term scope for energy-intensive industrial development in the Middle East is large. The constraint upon future expansion is neither economics nor markets, but rather the impending shortages of commercializable gas in many of the key oil-producing countries. The comparative advantage of Middle East oil exporters in many basic industries is now absolute; their production costs are the lowest in the world in most energy-intensive sectors. The current issue in most oil-exporting countries is the selection of the most valuable uses for their limited gas resources. Many options are feasible, but given the current scarcity of gas, it has become imperative to identify those yielding the highest returns.

The potential comparative advantage of the oil-exporting countries in heavy industry is substantial. It lies precisely in those industrial sectors which are either capital- or energy-intensive and which are at present faring least well in the countries of the Organization for Economic Co-operation and Development (OECD). As a result, there may be long-term major shifts in the location of basic industry.

The beginning of this trend is already apparent. Since the mid-1970s, the oil-exporting countries have been expanding capacity in those sectors in which the industrialized countries of the North are finding themselves compelled to rationalize, to mothball plants and to retrench. Highly competitive basic industries - primary metals, oil refining, basic petrochemicals, and certain industrial chemicals** are emerging in the Middle East.

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**The literature on industrialization in the Gulf usually focuses on specific single plants, the feasibility of which is tested against similar plants constructed elsewhere. Turner and Bedore have provided a non-analytical overview of the institutional questions, while Stauffer (1975) and GOIC/UNIDO have presented more comprehensive evaluations of economic feasibility. The Stauffer study derived gas values from structural costs in competing markets, while the GOIC/UNIDO studies assumed specific gas prices in the Gulf. Most of the detailed studies of individual industries or plants were prepared for potential investors and are proprietary.

This "reverse-wave" industrialization, emphasizing export-oriented heavy industry instead of the more customary light and intermediate industry oriented towards import substitution, is a significant step in the industrialization of the South. It also introduces certain opportunities for intensified South-South economic co-operation, while at the same time creating new forms of competition for existing industries in some of the newly industrializing countries (NICs) and thus introducing a new element in intra-South competition.

The scope for such industrial projects in the oil-rich countries will be analysed from several points of view. Consideration will first be given to the oil exporters themselves and to the implications of gas-based industry for them. The principal concern is to provide an explanation of the new economics of gas for basic industry, indicating why such industry today is eminently profitable, whereas only ten years ago it was not.

The implications of industrialization by the oil exporters for industrial trends within the broader context of the South will be dealt with. In particular, attention will be drawn to the possible impact upon a broad class of developing countries, including not only NICs, but also countries which are potential suppliers of labour, contractors, and raw materials. Areas in which the new industries will compete with similar plants in other developing countries - a dimension of intra-South competition which offsets some of the complementarities of co-operation - must also be considered.

After presenting the necessary background information, the paper deals with the following matters: opportunity cost of capital, with the implications of capital availability for both low- and high-absorbing oil-exporting countries; availability and evaluation of natural gas; structure of value-added in energy-intensive sectors, in particular measures of potential profitability and the relative economic ranking of various industrial options; and complementarities among developing countries, including opportunities for co-operation and areas of potential competition.

Industrial development strategies in the Middle East: background

The interest in industrial development in the Middle East is not new. The oil exporters share the desire of all producers of raw materials to add more value domestically to their exports of natural resources by integrating downstream into semi-finished and finished products.

This objective has become realizable, however, on a significant scale only since 1973, following the first quantum jump in the real price of oil. Prior to 1973, the cost of energy was so low that even free natural gas did not offset the other cost disadvantages of the oil exporters. Energy-intensive projects in the Middle East during that early period were comparatively rare and, if undertaken, were oriented towards the domestic market.

The few examples, other than the export refineries built by transnational corporations (TNCs) (Abadan in Iran, Ahmadi in Kuwait, and Ras Tanura in Saudi Arabia), usually proved unprofitable. The Shuaiba refinery in Kuwait and the Saudi Arabian Fertilizer Company, both initiated in the 1960s, were classic cases of premature ventures which were, until 1973-1974, at best marginally profitable.

Prior to 1973 the economic conditions were consistently unfavourable. Industrial projects needed to be justified on strategic grounds or rationalized as contributing intangibly to broader objectives of diversification. Since 1975, and especially since 1980, they have become economically viable without recourse to such non-economic justifications.

The economic conditions changed radically after 1973, when higher oil prices led to higher energy prices more generally. The fourfold to fivefold increase in overall energy costs created an economic umbrella for gas-based industries in the Gulf and then raised the umbrella high enough to offset start-up costs, extra infrastructural requirements and other disabilities.

Important new opportunities were created, because the price of oil had risen high enough to enable energy-intensive projects in the countries of the Organization of Petroleum Exporting Countries (OPEC) to compete with oil-fueled projects elsewhere. Since gas was so cheap, newer gas-based projects were able to yield a net positive value for the natural gas, over and above a reasonable rate of return on the invested capital, in spite of higher capital and operating costs than their OECD-based competitors. The new strategy was summed up as follows by the Saudi Arabian Finance Minister in his characterization of the objectives of Saudi Arabian plans for basic industries: "Its thrust will be aimed at diversifying our economies by helping to create a line of industries in which we, as oil producers and capital exporters, enjoy a comparative advantage". 1/

Throughout the oil-exporting countries, one has seen in the past ten years a rapidly growing number of basic industrial projects, reversing the usual priorities for industrial development and reflecting the special factor endowments of the oil exporters. Their comparative advantage lies in the relative availability of both capital and natural gas, and the rapid industrial expansion of the past decade has reflected this economic advantage (see table 1). In 1982 the total refining capacity of the countries of the Organization of Arab Petroleum Exporting Countries (OAPEC) amounted to 3.3 million barrels per day and facilities for an additional 2.9 million barrels per day were under construction. The refining capacity of the OAPEC countries by about 1987, when all plants will be on stream, will amount to approximately 15 per cent of total consumption of refined products outside the centrally planned economies.

The expansion in the manufacture of ammonia-based fertilizers has been no less dramatic. Total capacity will reach almost 9 million tonnes per annum in the late 1980s and, as in the case of refined products, represent a much larger fraction of total world trade. Ammonia or urea from the Gulf is especially competitive since, except for the United States of America and several developing countries with gas deposits, most ammonia manufactured throughout the world is based upon naphtha derived from crude oil, and the cost margin in favour of the Gulf producers ensures their markets.

Ethylene production is expanding even more rapidly, after a slower start, and plants already under construction in the OAPEC area alone will contribute 3 million tonnes to world supply in about five years. Once again the competitive edge is clear, since three quarters of all ethylene produced outside the OPEC states is derived from naphtha or natural gas liquids, the prices of which, except in the United States, carry a premium over crude oil, giving a clear comparative advantage to producers in the Middle East. However, the status of additional ethylene capacity in the

Table 1. Productive capacity in energy-intensive industries in OAPEC countries

(Millions of tonnes per annum) a/

Industry	Existing (1982)	Under way	Proposed	Total
Aluminium	0.4	0.3		0.7
Ammonia	4.4	4.1		8.5
Ethylene	0.5	2.5		3.0
Methanol	0.4	1.9		2.3
Refineries a/	3.3	1.8	1.1	6.2
Steel (direct reduction)	2.3	1.4		3.7

Sources: Organization of Arab Petroleum Exporting Countries, annual reports; aluminum: T.R. Stauffer, "Gas resources of the Middle East: locational implications for the aluminium industry", paper prepared for the Conference on Structural Change in the World Aluminium Smelting Industry, International Institute of Applied Systems Analysis, Laxenburg, 2 May 1984; steel: Metals Bulletin, various issues.

a/ Capacity of refineries given in millions of barrels per day.

area is uncertain, since construction of two large complexes in the Islamic Republic of Iran and Iraq has been indefinitely postponed by the war in the Gulf, and both facilities are understood to have suffered considerable damage.

Cement is another sector which experienced very rapid growth during the 1970s. In Saudi Arabia, for example, domestic production has increased almost eightfold since 1970, and the Gulf, once a major market for imported cement, is now essentially self-sufficient.

The interest of the oil-exporting countries in fostering industrial development, especially in the basic industries, is widespread, but consistent or systematic policies are in fact rare. With the striking exception of Saudi Arabia, the expansion of basic industries has involved ad hoc decisions taken on a case-by-case basis as opportunities were identified and proposals presented.

Broadly, however, all Governments have availed themselves of some mix of the following instruments to promote or facilitate heavy industry: modest tariff protection for domestic industry; preferential purchasing of domestic output by government agencies or contractors; concessional financing for industrial projects, for both domestic markets and export; provision of extensive infrastructure, either free or at very low cost;

supply of electricity and water at highly subsidized rates; and flexible pricing of natural gas.

Tariff protection and preemptive purchase clauses have been of limited importance to the basic industries, but the availability of low-priced energy and utilities have been major factors in overcoming initial barriers to the establishment of the larger industrial ventures.

Two basic considerations have been common to all major, gas-based industrial projects undertaken in the Middle East, namely the maximization of domestic value-added from the exhaustible resource, and the elimination of flaring of natural gas. However, beyond the universal interest in commercializing flared gas, there emerged several marked differences in the approaches to industrial development. The countries evolved rather different strategies with regard to the following three important aspects of their industrialization programmes: extent of project integration; modes of participation with foreign partners or the domestic private sector; and the mechanics of pricing gas to the enterprises.

Project integration

Although all the OAPEC countries have issued ambitious industrial development plans, industrialization objectives have been most systematically articulated in the case of Saudi Arabia, where a comprehensive plan for the establishment of basic manufacturing industry was conceived and implemented as an integrated programme.

Central to the Saudi Arabian programme was the creation of an extra-ministerial independent authority with full responsiblity for designing and implementing the projects together with the required infrastructure. The Royal Commission for Jubail and Yanbu, whose director has ministerial rank, was established as such an authority in 1975.

The scheme involved creating two virtually self-contained industrial parks at the ports of Jubail in the Eastern Province and Yanbu on the Red Sea. Not only the industrial facilities themselves but all the requisite infrastructure were included within the scope of the master plan. The scheme focused on basic industries, but also envisaged secondary industries, such as intermediate petrochemicals derived from the ethylene plants, and a broad range of tertiary support industries, since the complexes were large enough to support such a base.

The infrastructure, as an integral part of the plan, was designed in advance to encompass the full spectrum of primary, secondary and tertiary industries. Unlike industrial projects elsewhere, it was not plant-specific, but provided simultaneously the common support services and sites for a diversified complex of industries.

The potential joint economies of such an integrated scheme were large, but it entailed a massive mobilization of both planners and contractors. Both Jubail and Yanbu were minor dhow harbours prior to the inception of the projects in 1975, so that the Saudi Arabian programme had to create the full panoply of support structures, all the requisite housing, schools, and social services for two self-contained communities with a total population of over 250,000, taking into account an increase to nearly 400,000 by the year 2000.

Autonomy versus partnership

The most notable difference lies in the role assigned or permitted to foreign partners, ranging from 50-50 participation between foreign companies and the Government in joint ventures, on the one hand, to the extreme autonomous model where the Government owns 100 per cent of the industrial operations, on the other.

Saudi Arabia elected the participation model, and all the major heavy industrial projects in the Kingdom are 50-50 joint ventures. The Saudi Arabian Government is represented either by PETROMIN, the Government-owned oil firm, or by the Saudi Basic Industries Corporation (SABIC). Each partner contributes 15 per cent of the total capacity as equity, the Public Investment Fund lends 60 per cent at a nominal rate (approximately 2-4 per cent per annum), and the remaining 10 per cent must be raised from international commercial banking sources. Operating costs and output are shared pro rata, although marketing agreements exist in some cases whereby the foreign partner absorbs part of the Saudi Arabian share.

Radically different have been the strategies of Algeria, Iraq, Kuwait and the Libyan Arab Jamahiriya, which, in spite of their divergent ideological positions, have all relied upon totally government-owned entities. While all must use foreign process licensors and foreign contractors, the capital and ownership of the ventures lie entirely in domestic, government hands. Kuwait had experimented originally with mixed-sector firms, partly government-owned and partly local (national) stockholders, but the Government of Kuwait ultimately bought out the private interests and reverted to total government ownership.

The current status of industrial ventures in the Islamic Republic of Iran is somewhat obscure, but it appears that the plants are essentially government-owned, along the lines of the Algerian or Libyan models. Some of the earliest petrochemical ventures had involved foreign partners, but this was not continued with the later complexes.

The policies in the other Arab states of the Gulf are more heterogeneous. Bahrain involved foreign partners in its aluminium smelter, but the newest ventures - steel projects, a hydroprocessing cracking refinery and petrochemical plants - involve the participation only of neighbouring Arab states from the Gulf Co-operation Council. Qatar and the United Arab Emirates had assigned foreign partners minority interests in projects such as a liquified natural gas plant, a steel plant and an aluminium smelter, but otherwise reserved any ventures strictly for their national enterprises.

Gas pricing

There are also certain differences with regard to pricing gas. In most instances to date a purely notional price has been charged for gas, as in past times when gas was flared and offered as a free good (see below). In Bahrain and Qatar, for example, gas is transferred at a price of about $0.25 per thousand cubic feet (28.3 m^3) without provision for surcharge.

There are two noteworthy exceptions, however. Kuwait has increasingly tried to charge the market price for gas, reflecting its scarcity value in terms of crude oil prices. This policy extends to the pricing of

gas to power plants for domestic electricity. Saudi Arabia uses a different, less rigid device. It is reported to provide the gas at $0.50 per thousand cubic feet (28.3 m^3), corresponding to the very low valuation of $3 per barrel of oil equivalent. However, under the Saudi Arabian formula, there is a trigger once the venture achieves a threshold rate of return of approximately 15 per cent, at which time the gas price must be renegotiated in order to permit the Government to capture the resource rent.

Factor endowments: capital

An important advantage of the oil-exporting countries of the Gulf is their relative abundance of capital. Some, in particular the low-absorbing countries, have surplus capital, while some others, the high absorbers, run current account deficits. The latter still enjoy unused borrowing capacity based upon their large oil earnings. In both cases the opportunity and financial costs of capital are less than for most developing or developed countries.

The opportunity cost of capital, and hence the target rates of return on industrial projects, is significantly lower for the oil-exporting countries of the Gulf than for their competitors in developing or developed countries for the following reasons: no taxes are included in revenue requirements; and the hurdle rate of return for projects has been linked to the real rate of return on portfolio investment in developed market economies, that is, 1-4 per cent.

The opportunity cost of capital for the major oil-exporting countries differs from that applicable to most developing countries, the NICs or developed countries. The opportunity cost of capital must reflect their own special position in international financial markets, either as borrowers or net lenders, and also recognize their domestic fiscal regimes, in which both income and property taxes are often very much less than in the OECD countries.

In fact, the high real rates of return used for project evaluations by major lending organizations, such as the International Bank for Reconstruction and Development (IBRD), are not appropriate for most oil-exporting countries. Those discount rates are used by the IBRD as hurdle rates or screening rates to eliminate marginal, or relatively less attractive, projects in countries in which capital is scarce and where available funds must be directed towards the most remunerative projects. Since capital is scarce, only the best projects should be accepted, and a high opportunity cost, or rate of discount, is a screening device where ranking of projects is otherwise difficult.

In oil-exporting countries the parameters are different, and projects have hitherto been more scarce than capital. Thus a better measure of the opportunity cost of capital is the rate at which they borrow or lend in financial markets, since capital is not the binding constraint in their industrial development programmes. A distinction must, however, be made between two distinctly different types of oil-exporter: financial surplus states or low absorbers; and net borrowers or high absorbers.

In both cases the interest rate, whether on net borrowings or on net placements of funds, is the real opportunity cost of capital, the difference between the two cases being the bankers' spread.

High absorbers

The high absorbers are countries such as Algeria, which is actively borrowing, or the Libyan Arab Jamahiriya, Qatar and the United Arab Emirates, which have incurred deficits since oil markets stagnated after 1980-1981, but which cover the deficits by drawing upon financial reserves. More prominent examples outside the Gulf are Mexico, Nigeria and Venezuela.

The OAPEC countries have not reached any practical limits on their borrowing capacity, for the availability of capital to them seems to exceed the opportunities for investment in productive projects at home. The test of the opportunity cost is therefore the cost of additional debt, that is, the real, inflation-corrected borrowing cost, and projects are indeed evaluated using the interest charges as the opportunity cost.

The borrowing cost is usually specified as a premium that must be paid over the rate based on the London interbank offer rate in the London or New York markets, which has not exceeded 1.5 to 2.5 per cent in recent years. An upper limit for the opportunity cost of capital in such cases is therefore roughly equal to 200 basis points (2 percentage points) over the real interest cost for dollar loans in those two major financial markets (see below for estimate).

Low absorbers

For the capital-surplus oil-producing countries, the opportunity cost of capital is the rate at which they can place funds. This is more complex, because the Governments avail themselves of a wide spectrum of market opportunities, including not only debt instruments but also equities, real estate and direct investment. 2/

However, with the sole known exception of Kuwait, most of the surplus funds are still invested in the money makets, although with a mix of maturities ranging from the overnight market to long-term corporate and government bonds. A reasonable standard for the cost of capital to this group is the 30-day and one-year rates in both the London and New York markets.

The real yield is the standard rate less the rate of inflation, for which the United States wholesale price index is used. This is an appropriate method because the price of oil is denominated in dollars, as are a significant fraction of the imports and financial transactions of OPEC countries. The estimated real rates of return in United States markets since 1979 are shown in table 2.

The historical experience and that of the period 1982-1984 differ sharply. From 1945 to 1980 real rates of return in United States financial markets ranged between zero and approximately 4 per cent, as averaged over periods of 3-5 years. Bonds and United States treasury bills scarcely yielded a positive rate of return, while the stock market over longer periods yielded about 4 per cent.

Positive rates of return are a recent phenomenon, but there is no sign that the most current rates of 4-8 per cent (real) are viewed as typical and thus that they influence investment decisions. The opportunity costs of capital remain less in the Gulf than elsewhere.

Table 2. Indicative financial rates of return in United States markets

Item	1979	1980	1981	1982
90-day rate	14.4	17.6	13.8	9.9
1-year rate	12.9	14.9	14.8	10.4
United States wholesale price index	12.6	14.0	9.1	2.1
Estimated real rate of return	0-2	1-4	5-6	8-10

Sources: Morgan Guaranty Trust, World Financial Markets; International Monetary Fund, International Financial Statistics; United States wholesale price index.

Government-owned enterprises are willing to accept lower yields on their equity capital, or, as in the case of Saudi Arabia, highly subsidized finance is still available to industrial enterprises which otherwise meet the requirements for loans. Industrial ventures in Saudi Arabia can borrow from the Saudi Industrial Development Fund or the Public Investment Fund at nominal rates of 2-3 per cent for at least one half of the total capital requirement, although the short-term overseas investments of the Saudi Arabian Monetary Authority may yield real rates of return of 6-8 per cent.

For low-absorbing capital-surplus countries, the opportunity cost is still well below that desired in developed market economies given the absence of taxes or higher-cost equity capital. However, the 1.5 to 2-point premium now charged to the high-absorbing capital-deficit countries brings their cost of capital closer to that used in many developing countries and reduces their comparative advantage.

On balance, despite current deficits in some countries and retrenchment of general spending programmes, it still appears that industrial projects, if otherwise feasible, will continue to have high-priority claims on available funds, whether borrowed or internal, and that capital constraints will not affect the basic, energy-intensive industrial projects discussed here.

Factor endowments: availability and evaluation of gas

Gas is the key factor in the future industrial development of the Gulf, and it is necessary to focus on both the constraints upon the supply of gas and the economic implications of competing claims upon the use of that gas. Gas in the Gulf is still very cheap, but it is also valuable, all the more so because most is produced in conjunction with crude oil, so that volumes today are increasingly limited.

The gas reserves are indeed large, as are the ratios of reserves to production in most countries, but the figures as such are quite misleading. In most of the OPEC countries the gas reserves are associated gas, that is, gas that can be produced only in conjunction with the oil, pari passu, so that exploitation of the gas is inextricably and almost proportionally tied to production of oil. Kuwait thus has a 250-years supply of gas, based upon current production rates, but is nonetheless short of disposable gas because oil output is low, directly limiting gas availability in spite of the very high reserve-to-production ratio of 250 to 1.

The assessment of gas supplies in the Gulf must therefore look beyond the data on gas reserves and address directly the following three interrelated questions:

(a) What gas is available, given the distinction between associated and non-associated gas?

(b) What is the value of gas used in different industries or markets?

(c) What are the competing claims for gas and how can these be ranked?

We therefore must examine the gas supply parameters to establish the limits of gas availabiltiy and then inquire into the economic ranking of different gas-based projects. The derived or netback value of the gas in the sundry applications differ quite distinctly, and the hierarchical ranking of the energy-intensive projects must be based upon maximizing the rents to be obtained from the gas itself.

Gas supply

In most of the Middle East oil-exporting countries today gas is a scarce commodity and must be allocated to the most valuable uses. The supply-demand balance for gas in the Middle East has shifted significantly, and possibly irreversibly, over the past decade. Gas had been a free good throughout the early histroy of the Middle East oil industry, and most of the first tranche of gas-based industries in the Middle East were predicated upon free gas, or at least upon gas priced only at the cost of gathering and delivery.

Until very recently, the notion that gas is a free good was not at all unreasonable. Massive amounts of gas were flared for lack of any economically viable means of commercialization, and these conditions persisted until the end of the 1970s. Since then, however, the balance has changed for several reasons, including the following:

(a) Most gas in the Middle East is still produced as a co-product of oil output;

(b) Gas production rises or falls with the level of oil production and is thus intimately tied to international oil markets;

(c) The sharp drop in oil output since 1979-1980 has led to a commensurate cut in production of associated gas. In 1984 oil output in OPEC countries was about half its all-time peak, while production in Saudi

Arabia and Kuwait was at a still lower level, respectively about 40 per cent and 30 per cent of the peak values;

(d) The rising oil wealth has triggered rapid growth in demand for both electricity and water; gas needs for domestic consumption have risen more than proportionally. Electricity is generated using gas, and desalination plants based upon direct firing with gas, or upon heat extraction from gas-fueled power plants, provide much or all of the water supply for the countries on the southern littoral of the Gulf.

The resulting squeeze is two-sided, with rising domestic demand pressing closely against the falling production of associated gas, and this has led to gas shortages in many areas. At present oil production levels - approximately 18 million barrels per day for OPEC as a whole - there remains no significant marketable surplus of gas in the Gulf.

The figure shows the precipitate drop in gas production in the OPEC countries since 1979 and the steady rise in gas consumed for industry or utilities. Use of gas has risen further since 1982, the last year for which comprehensive data are available, while production has fallen by at least one third since then. Hence the margin between supply and demand has yet again narrowed. Moreover, even that assessment understates the supply gap, because the newest tranche of industrial projects and power plants is only now beginning to come on stream. Domestic demand should increase still further, exacerbating the squeeze.

The quantities of flared gas - the volume theoretically available for commercialization - remained roughly constant between 1970 and 1979, fluctuating between 120 and 140 billion cubic metres. This untapped energy source was indeed large. The disposable gas was the equivalent of about 2 million barrels of oil per day or equal to one third of total marketed United States gas production in 1980.

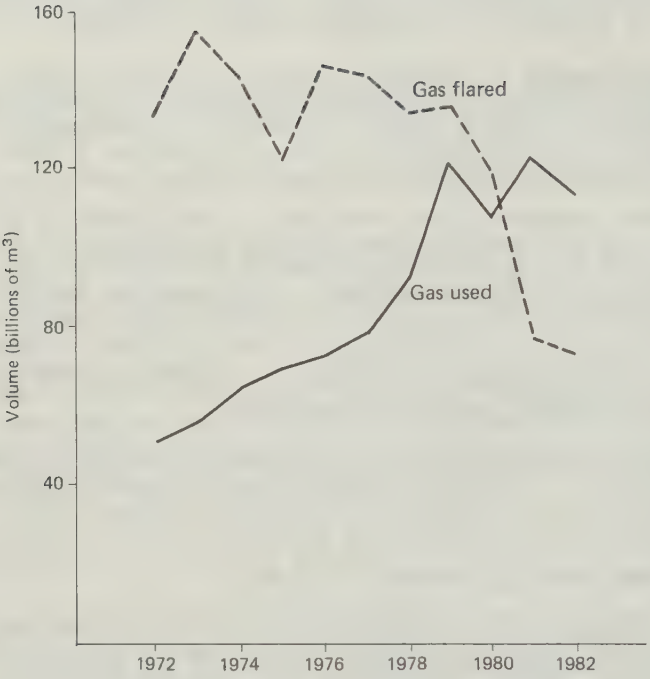
Local demand for gas within the OPEC countries also grew apace during the same period, tripling between 1970 and 1980 from about 40 billion cubic metres to 120 billion cubic metres per year. Gas is consumed largely for production of electricity or desalinating water, but industrial usuage has become increasingly important in recent years. Some gas has also been reinjected to sustain reservoir pressures as part of enhanced recovery schemes and is thus not available for commercial use.

Gas is now scarce, and the era of free gas is past. Indeed, gas will continue to be scarce in many of the oil-exporting countries unless world oil demand picks up markedly or until accelerated exploration programmes for non-associated gas bear fruit. The shortage does not affect all countries, however, and it is necessary to distinguish between the future "haves" and "have-nots".

Potential gas-deficit countries

Both Kuwait and Saudi Arabia illustrate the new circumstances of gas shortages: in the first case the spectre of shortage is real, while in the second it is imminent. Both have had to ration gas and to curtail industrial output at times since 1982, and both have intensified efforts to locate and develop non-associated gas fields which could be brought on stream as cushions against future fluctuations in oil output and associated gas volumes.

OPEC disposal of gas



Kuwait is already "out of gas". It relies entirely upon associated gas, and gas production is thus tied directly to oil output. Under the current OPEC oil production quota of 1.05 million barrels per day for Kuwait, assoicated gas output does not suffice to meet already established gas requirements for power, water, and the chemical plants. Already in 1982 (see table 3) only 10 per cent of total gas output was flared, and in 1984 all economically recoverable gas was fully exploited.

Indeed, ever since oil production began to be constrained after 1981-1982, Kuwait has been increasingly obliged to burn fuel oil in the power plants and marketable light products in the refineries. In mid-1984 it announced that it must begin to import liquefied petroleum gas since local gas production does not permit even that requirement to be covered, a futher sign of the domestic gas deficit.

In the case of Saudi Arabia, gas is still being flared, so that the gas deficit is imminent as distinct from immediate. However, a gap will emerge within a few years, by approximately 1986-1987, unless oil production once again rises significantly. Known commitments for natural gas, based upon power plants and factories now in operation or close to completion, exceed by a wide margin the available associated gas, even when all of the currently flared gas is connected to the distribution grid (see further discussion in section on priorities for gas-based industries).

Potential gas-surplus countries

Kuwait and Saudi Arabia epitomize the cases where gas is now scarce, but several countries, for example Algeria, the Islamic Republic of Iran and Qatar, have large known non-associated gas resources, and for them industrial development is not constrained by gas availability. Of the non-associated gas deposits only those in Algeria are connected and being produced on a large scale at the present time. The reserves in the three countries mentioned are large and constitute the bulk of the reported gas reserves for OPEC as a whole (table 3).

Table 3. Gas reserves and production: major Middle East oil exporters (1982)

Country	Reserves (10^{12} m^3)	Production (10^9 m^3/a)	Gas-oil ratio	Amount flared (percentage)
Potential gas-surplus countries				
Algeria	3.2	82.1	- a/	6
Iran (Islamic Republic of)	13.7	24.5	1 046	58
Qatar	1.8 b/	5.8	1 733	8
Potential gas-deficit countries				
Iraq	0.8	4.2	423	84
Kuwait	1.0	4.6	570	10
Saudi Arabia	3.4	33.6	575	64
United Arab Emirates	0.8	13.5	1 104	38

Source: OPEC, Annual Statistical Bulletin, 1982.

a/ The gas-oil ratio is not meaningful for Algeria because most of the gas currently produced is non-associated and because of the condensate fields in which gas is recycled.

b/ Published reserves do not fully reflect the North Dome; reasonably assured reserves are at least 2-3 times higher.

The non-associated gas reserves of the Islamic Republic of Iran exceed 11.3 x 10^{12} cubic metres, or alone are equal to about one half of the OPEC total. Those of Algeria are greater than 3.4 x 10^{12} cubic metres, while the resources of Qatar, if one includes the North Dome structure which is not yet officially reckoned with the reserves, are also well over 2.8 x 10^{12} cubic metres, although the official figure is still much more modest.

The costs of finding and producing non-associated gas are substantially higher than those for associated gas, where the costs are chargeable to the oil, the main product. These costs are nonetheless still very low by world standards, and the valuable by-products, liquefied petroleum gas and liquefied natural gas, are expected to cover a large part of the production and processing costs of any large non-associated gas finds.

Non-associated gas is in fact essential to the longer-run operation of an industrial base, since otherwise the gas-fueled industries become hostage to the oil production level. Even if the industries run largely on associated gas, a certain cushion of non-associated gas capacity should be kept in ready reserve to ensure operating flexibility.

Given the necessity for some cushion, the available volumes of associated gas in the Middle East, that is, those volumes of gas which are still being flared, provide a very limited basis for any further expansion of industry and must be reserved for power and water. Furthermore, even if oil output, and thus associated gas production, were to rise, some non-associated gas becomes almost a prerequisite since very high rates of utilization of associated gas are impractical without recourse to some back-up fueled source.

Valuation (opportunity cost) of gas

The opportunity cost of gas in the Middle East is a derived quanitity and depends upon a set of factors specific to each broad class of gas-using industries and to the circumstances of each plant.

The value and opportunity cost of gas will be regarded as identical, but we note that the Governments of Algeria and the Islamic Republic of Iran argue that the value of gas at the point of export (free on board) should be equal to no less than the value or price of crude oil. This represents a logical political posture for a gas-rich exporter, but oil parity (free on board) is a price which cannot be commanded on the market.

The gas value is the break-even price for that gas charged to any venture at which the gas-derived output of the venture is internationally competitive. There is a broad spectrum of possible uses for gas in the Middle East. The major industrial routes for commercializing gas are shown in table 4. However, before gas can be allocated to industrial applications there are preemptive claims upon any available volume of gas in each exporting country. In particular, domestic production of electricity and water desalination take first priority upon any supplies of gas.

The utilization of gas for enhanced recovery or reservoir pressure maintenance projects also has high priority and preempts gas from other industrial uses. Reservoir reinjection will be a critically important use of gas in the Islamic Republic of Iran in future, and will divert a large

fraction of available gas, including that from both associated and non-associated production, for a sustained period of 15-25 years.

In the Islamic Republic of Iran a massive programme was initiated during the mid-1970s, prior to the revolution, to inject very large volumes of gas into the oil reservoirs of the country. The dual objectives were to reduce, but not reverse, the rate of production decline, and to increase overall recovery by about one third. The gas requirements for that project alone were equivalent to the entire volume of associated gas, plus the dedication of an additional volume of non-associated gas of between 1.1×10^{12} and 2.3×10^{12} cubic metres.

The remaining possible industrial uses of gas fall into three categories. First is the export of gas as energy, converting it into methanol (methyl alcohol) or transforming it into liquefied natural gas. A related application is to use the gas to fuel a refinery, an application which is increasingly attractive because petroleum refining is becoming ever more energy-intensive, and the newest plants for producing a high-octane, lead-free gasoline or low-sulphur heavy fuel oil can consume 10-13 per cent of total crude oil runs as process fuel.

Table 4. Energy-intensive industries: competing energy sources

Industry	Energy source
Aluminium	
Refining	Oil, coal
Smelting	Hydroelectricity Coal- and oil-fired electricity Nuclear energy
Chlor-alkali	Electricity
Copper	
Smelting	Coal, oil, gas
Refining	Electricity
Ethylene	United States: ethane, liquefied petroleum gas Rest of world: naphtha
Fertilizers	
Ammonia (nh_3)	United States: natural gas Rest of world: naphtha
Urea	From NH_3
Liquefied natural gas	Heavy fuel oil (No. 2)
Methyl-tert-butyl-ether (MTBE)	Butane, methanol
Methanol	Heavy fuel oil (No. 2)
Refining	Crude oil, natural gas
Steel	
Reduction	Metallurgical coal
Mills	Electricity

The second category is the use of gas as a chemical feedstock. The manufacture of ammonia, which can be upgraded to urea, or of ethylene, the building block of the modern petrochemical industry, are the two most important applications. Both processes are conventional, and in both cases the gas-based plants in the Middle East would compete with the identical product manufactured using more expensive, oil-derived feedstocks in another area.

The final category is the export of gas embedded as fuel in industrial processes, such as the direct reduction process for producing sponge iron. A second option is burning the gas to generate electricity and then to produce aluminium ingot. Here the competitive status of gas is less unequivocal; gas as a reductant or as fuel for electricity generation competes only to a limited extent with oil. The competing fuels are metallurgical coal (steel) or oil, coal, hydropower or nuclear power (aluminium), depending upon the site of the competing facility.

The value of gas used in the various applications differs significantly. Under current conditions, where gas is relatively scarce, only the highest valued applications warrant priority allocation of the available gas.

Gas values are derived on a netback basis, that is, the values of the various products - liquefied natural gas, urea or aluminium ingot - are determined as the difference between the market value of the output of each process, less all the costs, except for gas. The residual, after deducting all costs of production, transport and marketing, is the value attributable to the gas, in other words, the maximum price or rent which can be charged for the gas and leave the industry competitive.

Specifically, the steps in deriving the netback value of gas in the Middle East are as follows:

(a) For the competing product, determine the full costs of production, including capital, raw materials and the opportunity cost of fuels or feedstocks;

(b) Deduct transport costs from the Middle East to the test market, including shipping costs from the source country to that market;

(c) Determine the full costs of production in the Middle East, excluding any charge for the gas as fuel or feedstock, but including any extra charges related to the Middle East site, and also allowing for possibly lower opportunity costs of capital for Middle East host countries;

(d) Establish the value of the gas charged to the plant as the difference between product value and product cost;

(e) Determine the unit value of gas delivered to the plant as the residual value divided by the total gas supplied, including plant losses or fuel. The residual charge per unit of inlet gas is the value used for ranking gas projects.

The procedure can be readily illustrated for the use of gas which is viewed by Middle East planners as the least attractive, liquefied natural gas. The calculation thus provides a benchmark assessment for the minimum value of gas, which can then be used as a threshhold test for the acceptability of other industrial projects.

The gas netback may be easily derived for liquefied natural gas competing in the consuming country against low-sulphur heavy fuel oil for boiler fuel, as in both Japan and most European markets, where gas is burned on a significant scale for electricity generation and industrial steam-raising. In that case the cost, insurance, freight value of gas delivered to the gas grid is equal to the ex refinery price of low-sulphur, No. 6 heavy fuel oil, plus or minus small adjustments for special quality factors and delivery charges.

The costs of marketing gas as liquefied natural gas are twofold. First, there are the fixed costs, independent of distance to market, of liquefying the gas at the point of export and the counterpart costs of regasifying it at the point of delivery. As shown in table 5, these amount to $1.23 and $0.55 per thousand cubic feet (28.3 m^3) of gas delivered, respectively. A further element is the fuel required for the liquefaction plant, averaging about 14 per cent of the throughput, which is valued at the derived netback, that is, total net realizations are divided by total gas supplied to the plant, including fuel.

The cost of transport in cryogenic tankers depends almost proportionately upon distance, except in so far as port turn-around times are determined only by loading and unloading rates and not by distance as such. For the case of a 12,000 km run to Tokyo from the Gulf, the freight charge is $2.23 per thousand cubic feet (28.3 m^3), including bunker costs and any boil-off liquefied natural gas used as fuel.

The resulting gas value is very much less than crude oil parity, even though the liquefied natural gas itself, once delivered to market, is a premium fuel. The netback ex liquefaction plant is the market value, taken as $5.00 per thousand cubic feet (28.3 m^3), less the three charges, which aggregate to $4.01 per thousand cubic feet (28.3 m^3), leaving only $0.99 as the value of the gas itself. The residual value is recovered from a total of 1,140 cubic feet (32.3 m^3) of input gas per thousand cubic feet (28.3 m^3) of output, so that the well-head value of the gas delivered into the liquefied natural gas system comes to $0.85, or $0.99 divided by 1.14.

The pricing of natural gas in areas which cannot be economically connected by pipeline to major consumption centres exhibits several distinctive features* deriving from the high conversion or transport costs, as illustrated in the preceding netback calculation for the use of liquefied natural gas. While it is beyond the scope of this study to compute the hierarchical rankings of gas for the various industries listed in table 5, several general points should be noted:

(a) Values depend strongly upon the use of the gas;

(b) For any given commercialization route the derived gas value depends strongly upon the particular submarket that is open;

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*For equal volumes of energy it is more costly to transport gas, given its lower density versus crude oil; hence the export value of gas usually is less than that of crude oil, despite the superior technical characteristics of gas as fuel.

(c) Since the highest-value markets are finite, lower-value options must also be considered, because it is improbable that any country could specialize in commercializing its gas in only one form.

The price of natural gas thus cannot be stipulated uniquely. It depends instead upon a number of considerations specific to each industrial venture in each location and for each market destination, including the following:

(a) The price of natural gas charged to an industrial project is a free parameter, which can be set at whatever level is needed to ensure profitability;

(b) Gas is no longer a free good, and a positive value is demanded for projects;

Table 5. Valuation of liquefied natural gas

Item	Dollars per 10^3 ft^3 (28.3 m^3)
Value (C.I.F)	5.00
Costs	
Regasification	0.55
Transport	
12,000 km	2.23
3,000 km	0.56
Liquefaction	1.23
Netback value	
Distance travelled	
12,000 km	0.99
3,000 km	2.65
Plant losses: 14% of input	
Plant inlet gas value	
Distance travelled	
12,000 km	0.85
3,000 km	2.28

Source: T.R. Stauffer, "Energy-intensive industrialization in the Arabian/Persian Gulf: a new Ruhr without water" (Teheran, Institute for International Political and Economic Studies, March 1975).

(c) The opportunity cost is tested against a set of possible projects, and the netback value attributable to the gas becomes an important part of the selection criteria;

(d) While a gas price below crude parity is acceptable, no Government has thus far been willing to price crude oil significantly below current market prices;

(e) Alternative but not generally accepted concepts for valuing gas have been advanced, in particular absolute export parity with crude oil (Algeria) and the present discounted value of its commercializable price in the distant future, which is equivalent in most cases to a current price much less than crude oil. The latter concept has been proposed by the IBRD in analysing gas-based industrial projects outside the OPEC states. 3/

Since 1979-1980 gas netbacks in the Middle East have been positive for all listed industrial projects, unlike the situation in the mid-1970s, prior to the last oil price increase which pushed gas values upwards.

Even though there is uncertainty how to price the gas, the absolute advantage of Middle East producers is clear, and the determinant of industrial expansion is not cost but rather the choice of industries and, in most countries, the likely availability of gas, since for most exporters associated gas, once a free good, is now in tight supply.

It is important to stress that Middle East Governments, irrespective of the size of their oil reserves, have been reluctant to use economic pricing for crude oil. Strictly speaking, the present-day value of a barrel of crude oil produced in 100-150 years time is likely to be very low, at any discount rate deemed reasonable. Hence it can be argued that the opportunity cost of using oil for industrial fuel is also very low, since the extra barrel burned today might not otherwise be produced for many years in the future. However, this argument is rejected by producer Governments, which tend consistently to value crude oil at its current market price less only the discount needed to sustain sales, thus leading to values much higher than the economic calculation. In the case of Kuwait, for example, the current reserves-production ratio, based upon proven and known reserves, is close to 200, so that the economic cost of a barrel of Kuwait crude oil for industry is the present value of a barrel of oil 200 years from now. Even if discounted at a mere 1 per cent, the value is only about $4 or approximately $0.65 per thousand cubic feet (28.3 m^3), much less than market parity. At higher discount rates the economic opportunity cost drops dramatically.

Implicit in the government valuations is a Hotelling-like model for oil pricing, that is, they value future production, however remote, at current prices, which is equivalent to presuming that the oil price will rise exponentially at the real rate of interest. This presumption was indeed made explicit at one point by the OPEC Long-Term Strategy Committee and remains residually and implicitly as part of a policy which does not discount future crude oil production.

Whatever may be the underlying logic, the fact remains that oil is valued at current prices and thus not discounted as either industrial fuel or industrial feedstock, so that oil-based industries, other than refineries, are not part of the industrial strategy in the Gulf countries or elsewhere among OPEC members.

Priorities for gas-based industry

As indicated earlier, energy-intensive industry in the Middle East today enjoys an absolute advantage versus most other sites in the world, especially for those industries where competitors outside the Middle East must rely upon natural gas (fertilizer) or upon costly petroleum derivatives.

The list of potential industries for the Middle East contained in table 4 are both energy and capital-intensive, matching the factor endowments of the oil-exporting countries of the area. In all cases, if gas as fuel or feedstock is priced at cost, new plants in the Middle East can undercut new plants located elsewhere and which are forced to pay market prices for oil or oil-parity prices for gas. They can compete favourably against older, largely depreciated plants whose fuel or feedstock prices are tied to oil.

While the absolute advantage of energy-intensive industry in the oil-exporting countries is clear, the relative advantages of the different industries and the priorities for claims on gas are less clear. The key issues affecting future industrialization in the Middle East are twofold. First, is there enough gas to satisfy domestic needs for electricity and water and still leave undedicated supplies for industry? Second, if gas is available, which industries yield the highest national return, net of the opportunity cost of capital and all input costs?

The first question addresses the issue of whether industrial development is constrained by lack of gas, either associated or non-associated, while the second focuses on the priority ranking of the wide spectrum of industrial options.

The preferred criterion for ranking industries, given a gas constraint, is the economic rent per unit of gas, that is, the value-added attributed to the gas itself, net of factor payments. We shall sketch here the considerations entering into that ranking, and indicate the severity of the gas shortage which delimits the future scope of industrialization in a number of the exporting countries.

Competing claims for gas

The various industrial uses of gas compete directly with domestic requirements under current conditions, in which gas is almost completely dedicated to existing or pending plants in most oil-exporting countries of the area. To measure the scope for future industrialization, it is useful to compare the gas requirements of a standard-scale plant of each of the major types against available gas supply.

A quick test of the scope for industrialization in those countries which rely upon associated gas is to determine how many barrels of oil must be dedicated to support a given plant in terms of the gas derived from that level of oil production. This will depend upon the gas requirements for a standard-size plant in each industry and also upon the amount of gas co-produced with the oil.

The gas-oil ratio varies from field to field in the Middle East, and it can also change no less widely over the lifetime of any given field. Oil production yields between as little as 300 cubic feet (8.5 m^3) and

over 1,800 cubic feet (51 m^3) of wet gas per barrel of oil, although for the major oil fields in the region the range is rather narrower, and an average gas-oil ratio of 500 is indeed representative (see table 3).

The major uses of gas are listed in table 6, where for each industry is shown the standard size of the world-scale competitive plant, the annual capacity factor, the volume of gas which must be dedicated to the plant over its expected lifetime, and the level of daily oil production needed to provide the plant with enough fuel if the gas-oil ratio is assumed to be 500.

Overwhelmingly important is the volume of gas required for electricity. Each 1,000 megawatts of power requires at full load the associated gas from at least 500,000 barrels per day of oil production. If the gas-oil ratio is higher, as in Qatar, for example, commensurately smaller volumes of oil production would need to be dedicated to the power plant. Thus, if the gas-oil ratio were 1,000 cubic feet (28.3 m^3) per barrel (which is rare in large fields), the requirement would still be 250,000 barrels per day.

If electricity is generated with the less efficient gas turbines or diesel engines, the requisite dedicated oil production level is even larger, approximately 700,000 barrels per day per 1,000 megawatts of generating capacity. Both kinds of station are still common in the Middle East, partly because of their particularly low capital cost and partly because they are modular and can be constructed much more quickly than the thermodynamically more efficient steam turbine plants.

Electricity demands are sizeable and now preempt a large and growing fraction of total available gas in the Gulf. Saudi Arabia, for example, anticipates at least 10,000 megawatts of installed power-generating capacity by the late 1980s, and Kuwait about 4,000. The electricity requirement alone will exhaust their associated gas supplies at peak load, based upon production levels of approximately 5 million and 1.1 million barrels per day, respectively.

Indeed, the associated gas of Kuwait is already fully committed. At current production levels of 800,000 barrels per day (May, 1984), liquid fuels are needed to supplement the last increments of associated gas.

Saudi Arabian requirements for natural gas for electricity and large industrial use will amount to 96 billion cubic metres per year once industrial and power projects currently under way are completed (see table 7). This concrete requirement is in fact a lower limit, since it does not include the additional gas needed for water desalination, gas plant fuel or small industry. Seventy per cent of this minimum total requirement is for electricity, with the remainder for the array of industrial schemes.*

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*There are additional fuel requirements for the ethane and LPG extraction plants. Depending upon the richness of the gas stream and the depth of extraction, plant fuel can consume as much as 15 per cent of total gas throughput. This is over and above the fuel needs for water programmes to be discussed later.

Table 6. Dedicated gas volumes

Industry	Plant capacity	Load factor	Dedicated reserves (million barrels per day of oil production)	Oil-equivalent volumes (thousands of barrels)
Aluminium smelting	150 x 10^3 t/a	0.9	0.7	125
Ammonia (NH_3)	1 500 t/d	0.85	0.4	100
Electricity				
Steam plants	1 GW	0.7	1.8	500
Gas turbines	1 GW	0.90	2.2	700
Ethylene	500 x 10^3 t/a	0.90	0.8	140
Liquefied natural gas	7 x 10^9 m^3/d	0.85	1.8	600
Methanol	2 000 t/d	0.85	0.6	150
Refining	250 x 10^3 barrels per day	0.90	1.5	500
Sponge iron (direct reduction)	800 x 10^3 t/a	0.9	0.4	70

Source: T.R. Stauffer, "Gas resources of the Middle East: locational implications for the aluminium industry", paper prepared for the Conference on Structural Change in the World Aluminium Smelting Industry, International Institute for Applied Systems Analysis, Laxenburg, 2 May 1984.

Notes: 1. Dedicated reserves are the volumes of gas required to fuel the facility over its expected economic lifetime.

2. Oil-equivalent volumes denote the oil production level required to fuel the given facility at a representative gas-oil ratio of 500 cubic feet (14.2 m^3) per barrel of oil.

3. Electricity: heat rate for steam plants, 10,000 Btu/kWh, for gas turbines, 14,000 Btu/kWh. Plant lifetimes: steam, 30 years, gas turbines, 20 years.

4. Refining: total fuel externally supplied; refinery gases assumed to be recovered and marketed.

5. Ethylene: based upon methane equivalents.

Table 7. Gas demand in Saudi Arabia: industry and power (Mid-1980s)

Item	Installed capacity	Gas requirements (10^9 ft^3/a) a/	Equivalent oil production (millions of barrels per day)
Electricity	15.6MW	2 500	4.3
Industry			
Refining	1.2×10^6 barrels per day	366	0.6
Ethylene	1.6×10^6 t/a	230	0.4
Methanol	1.3×10^6 t/a	150	0.3
Fertilizer	1.0×10^6 t/a	110	0.2
Steel	0.9×10^6 t/a	40	0.1
Total		3 400	5.9

Source: Royal Commission for Jubail and Yanbu, Annual Report 1982.

Notes: 1. All figures rounded.

2. Electricity production: one-half gas turbine, one-half steam turbine; load factor, 0.55

3. No allowance for water desalination energy requirement.

4. Gas-oil ratio, 575 cubic feet (16.3 m^3) per barrel (1982).

5. Ethylene: volume computed as methane equivalent.

a/ 10^9 ft^3 = 2.832×10^7 m^3.

That volume of gas, excluding the requirements for water, would require a minimum oil production level of 5.9 million barrels per day, which is above the residual production quota alloted to Saudi Arabia under the current OPEC agreement. Known needs thus already exceed currently established production.

Indeed, the required production level would in practice need to be substantially higher to allow for operating fluctuations, since electricity demand and oil production are seasonal and disproportionate, with water and electricity requirements highest in the summer when production traditionally has been lowest. Present schemes may in fact require an even higher annual average production level of at least 8 million barrels per day to cushion seasonal effects and unavoidable losses and provide a safety and turn-down margin and fuel for the gas processing plants.

Water production in countries requiring desalination further adds to domestic non-industrial energy needs. No survey of fuel requirements for desalination facilities has been found. However, in most instances the water plants are coupled to power plants and fueled by waste heat, so that the maximum additional fuel required for water desalination can be related to the total fuel requirement for electricity generation.

Desalination plants add directly or indirectly to total energy inputs for the production of electricity, even where the exhaust heat is used, since back-pressuring turbines and exhausting steam require additional heat input in a steam turbine plant because the turbine is less efficient in such an operating mode. It may be very roughly estimated, based upon prevailing water-power ratios, that water needs will add approximately 20 per cent or more to the energy inputs for electricity production under operating conditions where the waste heat is fully utilized. Even where exhaust heat from combustion gas turbines is recovered for desalination plants, without the additional electricity from using a combined-cycle plant the energy opportunity cost is about 40 per cent of the full-load input energy.

Joint domestic needs for electricity and water are thus already the major source of demand for gas. In Saudi Arabia, for example, it is estimated that one half of all gas, even at prior historic peak production levels of 10-11 million barrels per day, would have been required to meet already scheduled domestic needs for water and electricity. At current production levels the balance is more precarious, and it has been shown above that a lower limit for estimated gas needs already exceeds scheduled production within a period of 3 to 4 years.

Other industries also consume large volumes of gas. Refineries and liquefied natural gas plants require particularly large volumes of dedicated production. In each case the standard facility consumes roughly the same quantities of gas as a 1,000-megawatt power plant, so that such facilities commit significant fractions of the associated gas available at current oil production levels. The Saudi Arabian refineries and ethylene plants together will consume gas equivalent to one fifth of oil production under the 1984 quota alloted to Saudi Arabia.

The other plants require more modest volumes of gas, ranging from 70,000 barrels per day of oil production equivalent for an 800,000 tonnes-per-year direct reduction plant to 125,000 barrels per day for an aluminium smelter of 150,000 tonnes per year. These volumes, however, loom larger when electricity and water needs command a large fraction of available gas, so that the margin left for industry is narrower.

On balance, the scope for large new industry in the Gulf is limited at present by the overall availability of associated gas. However, several factors have an impact on the gas constraint and could help to make it a temporary phenomenon. The following points should be noted in this connection:

(a) If global demand for Middle East oil rises, the available gas rises disproportionately because local uses of gas remain almost stagnant, and the constraint would no longer be binding. However, given the need for a cushion against production fluctuations, a considerable increase would be needed in both Kuwait and Saudi Arabia;

(b) Significant discoveries of non-associated gas would provide the needed flexibility. While dry gas is more costly to produce, its cost is still very low in relation to its commercializable value, and the feasibility of the industries is not seriously affected;

(c) Nuclear plants could relieve the demand for gas for power generation, a strategy proposed both by Iran and Egypt and now being discussed by Iraq as well.

A small group of the exporters already have large reserves of non-associated gas, and three countries, Algeria, the Islamic Republic of Iran and Qatar, are particularly well endowed. The reserves of Algeria are more than enough for a major expansion of gas-intensive industry. The Islamic Republic of Iran has even larger reserves, but large volumes are needed for the long-term reservoir reinjection programme. This would require most or all of the currently produced associated gas, as well as a sizeable fraction of the non-associated reserves.

Qatar has reserves large enough to supplement foreseeable needs in the Arab Gulf states, as well as any imaginable needs of its own. A pipeline grid to connect Qatar with Bahrain, Kuwait and Saudi Arabia is under discussion by the Gulf Co-operation Council. Transmission costs, plus the well-head price likely to be required by Qatar, considerably reduce the attractiveness of any ventures located outside Qatar. Hence this option, while technically feasible, offers little economic incentive to other partners, unless the gas rents are split through some innovative formula.

The prospects for further industrialization in the Gulf, and thus for the related development of South-South co-operation, hinge first and foremost upon how the now scarce supply of undedicated gas can be either expanded or most efficiently allocated.

Industry priorities

It is beyond the scope of this review to calculate the gas netbacks associated with each industrial option, although the available evidence suggests the relative rankings in terms of the derived well-head value of the gas which can be realized in each case.

A key element in commercializing gas is the relative cost of conversion of the gas embedded in the product, including both differential processing costs and transport differentials, which form a basis of comparison of the products and their competing sources. One simple test is the cost of transporting gas to the market in different forms. Each of the processes covered in table 8 is interpreted as a means of commercializing or marketing natural gas without building a pipeline, that is, by converting the gas into a form more amenable to shipment. In each case, the shipping cost is a measure of the relative penalty for commercializing gas in that form.

In table 8 are shown the volumes of gas embedded in each of the major export options, together with illustrative costs of transporting the final products from the Gulf to Japan or an East Asian customer. The shipping costs cluster into three categories. The lowest cost per embedded 1,000 cubic feet (28.3 m^3) is found for the manufacture of aluminium ingot or methanol. For both products the gas transport costs are less than $0.5 per contained 1,000 cubic feet (28.3 m^3) of gas.

The highest transport cost is for the case where the gas is marketed directly as energy in the form of liquefied natural gas, rather than as an industrial product. The cost depends very strongly upon distance, but for the transport of liquefied natural gas between the Gulf and Japan, the nearest industrialized customer, the transport cost is about $3 per 1,000 cubic feet (28.3 m^3), including regasification and liquefaction charges.

The other gas-intensive products involve shipping costs of between one and two dollars per unit of contained gas. The figures are less precise because the goods would be partly shipped in smaller lots and at spot rates. Sponge iron and ammonia are parcel trades, since the monthly output of typical plants could not fill standard vessels.

However, the transport penalty could be less under certain conditions for urea, sponge iron and steel products. In those cases, Middle East exporters could enjoy an additional freight advantage from backhaul trades, since outgoing freight rates tend to be lower. This arises because the region exports little general cargo compared to that moving inwards. Outbound ships are either unladen or underladen, so that the competition for cargo is intense and rates are accordingly much more favourable, a condition which is expected to prevail in the foreseeable future.

Table 8. Energy-intensive industries: key parameters

Type of export	Volume of embedded gas (10^3 ft^3/t) a/	Shipping (dollars per t) b/	(dollars per 10^3 ft^3) a/
Aluminium c/	180	40	0.25
Ammonia (NH_3)	38	40	1.00
Ethylene	65	50-80	0.90-1.20
Liquefied natural gas d/	-	-	3.25
Methanol	32	8-12	0.25-38
Refined products	5	6-8	1.20-1.60 e/
Sponge iron (DRI)	14	20	1.43

a/ 1,000 ft^3 = 28.3 m^3.

b/ For trade flows from the Gulf to Japan.

c/ Based upon integrated smelter which manufactures its own anodes; does not include refining of alumina, which is presumed to be imported.

d/ Transport cost includes costs of liquefaction and regasification.

e/ Total shipping cost for refined products, not differential cost in relation to crude oil.

The range of shipping costs suggests that the netbacks differ strongly among industries, a fact which is supported by project studies including not only differential shipping costs but also differential conversion and processing costs between the Gulf and competing locations. Representative values of the gas netback (residual producers' rent) for a cross-section of industries are shown in table 9, which illustrates the wide range - ten to one - of relative gas values.*

Table 9. Ranking of gas valuations

Industry	Netback value (dollars)
Hydrocracking refinery	3-6
Chemical methanol	5.50
Liquefied natural gas (3 000 km route)	3.75
Aluminium (nuclear or coal power)	3.50
Liquefied natural gas (12 000 km route)	1.25
Aluminium (hydropower)	1.00 a/
Methanol (motor fuel)	0.50 a/

Source: T.R. Stauffer, "Gas resources of the Middle East: locational implications for the aluminium industry", paper prepared for the Conference on Structural Change in the World Aluminium Smelting Industry, International Institute for Applied Systems Analysis, Laxenburg, 2 May 1984.

a/ Approximate value.

Refining yields the highest netback gas value, from $3 to $6 per 1,000 cubic feet (28.3 m^3), depending upon operating conditions; the more intensive the processing, the greater both the energy and capital intensity of the plant, and hence the greater the relative advantage of the Gulf producers.

The case of methanol illustrates the differentiation among markets. Chemical-grade methanol proves to be a valuable outlet for gas, while fuel-grade methanol is quite unremunerative. For chemical methanol, where

*The gas valuations have been derived from a mix of published sources and unpublished consultants' studies; see Stauffer (1984) and GOIC/UNIDO.

a Gulf manufacturer competes against methanol produced elsewhere from light petroleum products, the advantage is very large and the gas value over $5 per 1,000 cubic feet (28.3 m^3). This results partly from the capital cost advantage and partly from the relatively low costs of shipping methanol, which can be transported at a small premium in conventional product tankers.

The gas value is scarcely one-tenth as high - about $0.5 as opposed to $5 - if methanol is produced for motor fuel. In that sub-market the value of methanol is closely related to the value for high-octane gasoline blending stocks, and, even allowing for its high RON blending numbers, the high costs of manufacturing methanol cut deeply into the value of the input gas. 4/

Liquefied natural gas illustrates the impact of geographical differentiation of markets, since the costs of shipping it in cryogenic tankers are so high that the netback value proves to be extremely sensitive to distance. For a short-haul trade, such as across the Mediterranean, the shipping costs are less than $1.00 per 1,000 cubic feet (28.3 m^3) and the netback value, after deducting all processing and shipping charges, is $3.50-$4.00 per 1,000 cubic feet (28.3 m^3). However, for longer-distance trade, such as the 12,000 km run from the Gulf to the United States, the netback is only about $1.25.

More generally, under post-1980 market conditions, even with the recent fall in real oil prices, all such industrial ventures are potentially feasible in the sense that they yield a positive netback value for gas. Moreover, even though some markets, such as chemical-grade methanol, offer particularly high netbacks, the highest-value options are limited, and lower-value uses must be considered.

Complementarities and conflicts

Industrialization in the Gulf creates some complementarities with the rest of the third world and also new intra-third-world competition, so that a ready balance of benefits and burdens cannot be drawn. Some of the heavy industry in the area preempts growth in those sectors in developed countries or competes directly with existing under-utilized capacity, but some of the new capacity in the Gulf also displaces exports from NICs.

We outline below the areas in which industrial ventures in the oil-exporting countries offer opportunities for South-South co-operation and also note where new industrial ventures in the oil-exporting countries compete directly with industrial projects in other countries of the South, including those which may benefit from the construction projects for the plants which later challenge their own.

Complementary facets

The first and most obvious complementarity lies in the opportunity for contractors from other countries of the South to participate in the construction of new industrial projects or for their engineering industries to supply equipment. The other principal complementarity involves the following two forms of backwards integration: opportunities for the countries of the Gulf to invest in developing countries to obtain the raw materials for their new industries; and possibilities for NICs to inte-

grate backwards into joint ventures in the Gulf for production of basic chemicals or intermediate products for their own domestic industries.

Industrial and infrastructural projects in the Gulf offer real opportunities for contractors and construction firms in the South. Since the plants are to be built primarily in the Gulf, it is expected that Asian contractors, in particular, will be heavily involved in the projects, reflecting their already important role in the region. This represents added business in the sense that such plants replace comparable facilities in the OECD countries, where Asian labour or firms would have little entry, and new ventures of this type in the Middle East are truly incremental.

While it is reasonable to expect that Asian firms, in particular, might capture a sizeable share of the contracts, it must also be noted that the input would largely cease once construction has been completed. Labour requirements for such projects, all being eminently capital-intensive, are comparatively small and, moreover, the needed skill levels tend to be quite high. Follow-up sales are likely to be small.

A second area of complementarity is the possible supply of raw materials for the energy-intensive industries. The major industries are listed in table 10, together with their most important raw materials other than energy. The inputs are specified along with the developing countries which are potential sources of supply.

Table 10. Principal raw materials for energy-intensive industries

Industry	Raw material	Developing country sources
Aluminium	Bauxite	Guinea, Jamaica, Suriname, Brazil, Guyana, India, China, Dominican Republic
Chlor-alkali	Salt	India, Brazil, Turkey, Benin, Bahamas, Pakistan, Argentina
Copper	Copper ores (various)	Chile, Zambia, Zaire, Peru, Philippines, Papua New Guinea
Fertilizers	Phosphates	Morocco, Jordan, Togo, Brazil, Nauru, Christmas Islands, Senegal
Steel	Iron ore	Brazil, India, Liberia, Mauritania, Chile, Peru, Democratic People's Republic of Korea

Source: United States Bureau of Mines, Minerals Yearbook.

Notes: 1. Production in oil-exporting developing countries excluded.

2. Sources listed in descending order of total production.

The opportunities are surprisingly limited, and the only two large inputs are bauxite for aluminium smelters and iron ore for the direct reduction plants. Bauxite can be supplied by a range of countries in the South, from Guinea to Brazil or India, but the most aggressively competitive exporter of bauxite, and currently the major source for the Middle East, is Australia, which, while a major exporter of raw materials, ranks with the developed countries of the North.

Backward integration by oil-exporting countries into the supply of industrial raw materials from developing countries has in fact already begun on a small but systematic scale. Kuwait, starting in the early 1970s, evolved a major financial interest in the iron mines of Mauritania, which, however, thus far is only a theoretical form of backward integration since its own steel project has been shelved and the Mauritanian ores are marketed elsewhere.*

One noteworthy venture is the bilateral arrangement between India and the Islamic Republic of Iran, involving trade in iron ore and crude oil, a model which may be repeated in the future. Indian iron ore is supplied to the steel works in Isfahan under a long-term contract, while Iranian crude oil is shipped to the Madras refinery in India, in which the National Iranian Oil Company holds an equity interest.

Active co-operation has also emerged in the manufacture of compound fertilizers. Kuwait has taken the lead in this sector, and phosphates from Jordan and Tunisia are being processed with ammonia, principally from Kuwait, to produce compound fertilizers. Intra-regional, intra-South joint manufacturing activity in this specialized sector is expected to expand, in line with plans for expansion of phosphate production in Egypt, Jordan, Morocco and Tunisia. Such activities are limited to those few developing countries with exportable phosphate deposits.

Kuwait also participates in two interconnected fertilizer ventures in Tunisia, the Industrie chimique maghrébine and the Société engrais de Gabès, which produce diammonium phosphate and phosphoric acid. the complementarity between the gas-derived nitrogen supplies of Kuwait and Tunisian phosphate deposits is particularly clear. Provision has been made for future extraction of uranium from the phosphoric acid plant, since the Tunisian deposits contain over 100 parts per million of recoverable uranium.

Kuwait and several other Arab oil producers are also involved in three ventures for the integrated manufacture of fertilizers in Jordan, the Arab Potash Company, the Jordan Phosphate Mining Co. Ltd., and Jordan Fertilizer Industries, which supply the potassium (potash) and phosphate for processing with Kuwaiti gas-derived nitrogen (ammonia).

However, Australia remains as an important and effective competitor to developing country exporters of both bauxite and iron ore. It has large high-grade deposits and its industry is efficiently organized. Moreover, the distances are comparatively short, compared with African or Latin American sources, and this advantage could be enhanced by the use of open bulk ocean carriers.

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*F. Grosrichard provided an accessible survey of that facility in Le Monde, 24 July 1984, pp. 13-14.

There are also a few isolated examples where NICs have undertaken joint industrial ventures in the oil-exporting countries. A fertilizer company of Taiwan Province of China has a partial interest in one of the ammonia-urea complexes at Jubail, as a partner with SABIC, and its share of the output will replace very high-cost ammonia produced in Taiwan Province from naphtha. Similarly, a conglomerate of the Republic of Korea, the Lucky group, has announced its participation with SABIC in a polyvinyl chloride plant to be constructed in Jubail using local ethylene.

Both of the latter two cases represent a form of adaptive complementarity, since the two projects are in effect substituting for related plants located in Taiwan Province of China or the Republic of Korea, respectively, which would have used the much more expensive liquid-derived fuels or feedstocks. Both ventures displace domestic capacity but do provide for participation.

Intra-South competition

The possibilities for South-South competition are real, and industrial ventures in the Gulf compete directly with analogous industries located elsewhere in the South. Many of the key industries targeted by the OPEC countries are identical to those which rank high in the industrial priorities of many developing countries or NICs, steel, fertilizers, refining and petrochemicals being the most prominent examples. In this respect the industrial aspirations of the oil-exporting countries parallel those of the other aspiring non-industrial countries or NICs, so that the scope for competition between oil exporters and NICs is indeed fundamental.

Thus, across the board, all gas-based Middle East industrial projects, except for those involving developing country exports, will compete against plants located either in the South or the North, directly or indirectly. The competition is likely to be particularly direct with regard to refined products, petrochemicals, steel and fertilizers, where markets are especially fragile due to large overcapacity at the present time, and where the cost advantage which the associated gas gives to Middle East producers is quite large in relation to prevailing profit margins. More generally, the competition will arise in the three different classes of markets described below.

Import substitution

Local production in the Middle East serves first to provide substitutes for imports. The reduction of imports from both NICs and developed countries has already been observed in the case of aluminium ingot, steel construction materials, and basic petrochemical intermediates. The process is especially successful in the case of cement, in which the Gulf is today largely self-sufficient, eliminating a once lucrative export market for both European and Asian producers. Local Middle East manufacturers compete here most directly with NICs, because both concentrate on the more basic products with lower value-added.

Home markets (NICs and developing countries)

Middle East exports can compete actively in the home markets of other countries of the South in those product areas where the comparative advan-

tage of the Middle East is greatest, in particular products manufactured elsewhere using petroleum or gas as feedstocks or where electricity costs are tied to oil. Methanol, polyvinyl chloride, ethylene, refined products and aluminium from the Middle East enjoy both an absolute and a comparative advantage and can be priced to compete favourably in most markets. The transport advantage enjoyed by the home market in these cases, as discussed earlier, is relatively small in comparison with the cost advantage enjoyed by producers of cheap gas. Fertilizer production is particularly exposed.

Third-country markets

Third-country markets are smaller, but here also Middle East exporters of aluminium and fertilizers, in particular, will actively compete with plants from other developing countries or NICs. In these markets even the limited transport advantage of the non-Middle-East producers is reduced, since both must incur transport costs. The opportunity for Middle East exporters to obtain backhaul shipping rates is important in this context and adds to their comparative advantage. Over the medium-term, however, the Middle East is not likely to export more processed products, since output there may not suffice for internal consumption, or would be most probably consumed at least within the region. The new aluminium rolling mill in Bahrain, for example, will principally reduce imports to the whole Gulf area.

To some extent there is, at least in principle, also scope for South-South co-operation in some of the above-mentioned areas. Where the comparative advantage derived from Middle East gas is highest, new capacity destined for markets in the South can be constructed as joint ventures between NIC firms, especially, and local oil or industrial companies.

One such joint venture, a fertilizer plant at Jubail jointly undertaken by a firm of Taiwan Province of China and SABIC, has already been mentioned. However, it is doubtful if many more will emerge, partly because foreign participation, whether by TNCs of developed countries or by firms from NICs, is rather rare and, indeed, is standard practice only in Saudi Arabia.

The following conclusions may therefore be drawn:

(a) Limited South-South complementarity exists in terms of raw material supplies, principally iron ore and bauxite;

(b) Considerable short-term complementarity exists in terms of opportunities for NICs or developing country construction firms for building and equipment contracts;

(c) Significant competition between the oil-exporters and other developing countries is emerging in terms of steel products, fertilizers, refined products and petrochemical intermediates;

(d) The competition appears in all markets, in those of third parties as well as the domestic markets of the principle parties involved.

Notes

1/ Abdulaziz al-Zamil, Middle East Economic Survey, 8 February 1982, interview.

2/ Bank of England, Quarterly Bulletin, various issues.

3/ G. Schramm, "The economics of gas utilization in a gas-rich oil-poor country: the case of Bangladesh", Energy 1, vol. 4, No. 1, pp. 47-64.

4/ J.F. Rischard, Emerging Energy and Chemical Application of Methanol: Opportunities for Developing Countries (Washington, D.C., World Bank, 1982).

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FINANCIAL RECONSTRUCTION FOR NORTH-SOUTH AND SOUTH-SOUTH TRADE

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The international economic system suffers today from a self-inflicted paralysis. Each country, guided by an illusion of national self-interest, attempts to act in isolation in a highly interdependent world economy. The ideology of the nation-state and economic sovereignty encourages the pursuit of national self-interest, although the action of individual countries often has a global impact because of international economic interdependence. The consequences of action by an individual country and the global reaction pattern that it precipitates are beyond the control of that country. In short, the ideology of national economic sovereignty gives rise to individual economic action with virtually no control over the consequences of such action.

Perhaps the situation is best illustrated by the consequences of restrictive monetary and fiscal policies followed by some developed countries in response to the accelerating inflation of the recent past. Restrictive monetary policies, particularly in the United States of America and the United Kingdom of Great Britain and Northern Ireland, made interest rates, such as the London interbank offer rate and the United States prime rate, soar up in major financial centres. With almost 75 per cent of Eurocurrency private loans denominated in dollars, the domestic interest rate of the United States exerted a strong influence on the international capital markets. This in turn increased the cost of borrowing finance, choked off investment and pushed up bankruptcy rates to unprecedented heights, creating a climate of great economic uncertainty and aggravating the debt service burden of deficit countries. To illustrate the last point, during the year 1980/81 additional payments by developing countries due to higher interest charges amounted to approximately $18 billion. The real cost of fighting inflation through monetary restrictions assumed enormous proportions, in terms not only of mounting unemployment, but, more significantly, of a reduced momentum in the expansion of world trade experienced during the decades following the Second World War. With slower growth in world trade, the international economic system as a whole increasingly felt the constraint of insufficient effective demand which paralyzed growth and precipitated unemployment in most countries.

It is not always realized that the world debt crisis, despite the increase in the external debt of developing countries to over $500 billion, had at least a temporary economic advantage. Access to large-scale commercial borrowing, particularly by a group of newly industrializing middle-income countries, partially sustained the tempo of expansion in the

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volume of world trade. Without access to credit, the constraint of effective demand on world trade would have been still more severe and might have precipitated an economic recession sooner. Hence there is a need for a more balanced view of the world financial situation as essentially a reflection of underlying international trade relations, without exclusively focusing on the immediate financial nature of the crisis and the insolvency of some of the heavy borrowers.

Any system of international financial arrangements must be designed to oil the engine of international trade through which the achievement of major national economic objectives such as full employment and reasonably high and steady growth - a precondition for taking advantage of new technology and investment - becomes feasible. The environment of international trade must therefore promote rather than hinder the achievement of those objectives. Unfortunately, this has not happened. Since the official abandonment of the Bretton Woods system in 1973, the world economy has been gradually moving into a long-lasting recession of terrible proportions, in which the surface phenomenon of a financial crisis has been allowed to overshadow the basic economic crisis. However, the world debt crisis must be recognized as a symptom of a deeper malfunctioning of the world trading system. Any meaningful financial solution must be set in the context of a policy of expansion of world trade consistent with the national objectives of full employment and reasonable growth. Only in this way could national self-interests be harmonized within a framework of international economic interdependence. International financial arrangements must be consistent with that overall goal. Rather than trying to find purely financial solutions to a financial crisis, ways must be found to tackle the fundamental national objectives of employment, growth and stability within a meaningful framework of international trade and finance. When the existing framework is found inadequate, a more appropriate framework must be devised to allow countries to pursue their self-interests without triggering off an economic and financial crisis on a global scale. For unless the interdependent world economy is protected from such crises, each individual act of national self-interest will ultimately be self-defeating and the participants in the world economic system will be collectively worse off. Such a critical situation may already be in prospect. Hence there are compelling reasons to devise policies that could be readily implemented and would contribute to the building of a more appro priate framework of mutually beneficial economic relations among countries.

Unfortunately, the economically more privileged countries of the North may not yet be willing to accept the full implications of global economic interdependence. Their freedom of action in national economic policies, although self-defeating in the longer term, may prevent them from accepting any internationally negotiated growth strategy in the fields of employment, output and trade. In particular, the fear of inflation or even longer-term structural adjustments in the world economy that may gradually curb their dominant economic influence may cause the industrially powerful countries of the North to reject a strategy of high growth for themselves or one of still higher growth, consistent with the Lima target, for the countries of the South. In short, they may fail to reflate their economies and refuse to co-operate on the basis of a genuinely international approach to economic management.

In such circumstances, the countries of the South, which have a greater stake in faster economic growth and a restructuring of the world economy through the application of new technologies and rapid industrial development, would have no choice but to fall back on a defensive strategy or contingency plan to cope with the negative effects of the failure by

the North to extend its full co-operation. In view of the existing conditions of international economic interdependence, this is clearly a second-best solution. However, it is a second-best solution that has to be accepted because the economically powerful North may refuse to play its appropriate role on the international economic scene. A contingency plan based primarily on South-South or intra-South co-operation assumes significance precisely for this reason. It could be argued that there are different levels at which international institutional arrangements may be visualized. At the highest level, there are optimal institutional arrangements and policy options based on a genuine recognition of international economic interdependence by all the parties concerned. These are in the nature of "first-best" solutions, resulting from an awareness of mutual interest by North and South. On a lower level, such a mutuality of interest is not recognized through the arrogance of power currently enjoyed by the North, and institutional arrangements and policy options have to be devised almost entirely on the basis of South-South co-operation. Although these may be in the nature of second-best solutions, they would be shaped by a dynamic ideology, the ideology of collective selfreliance of the less privileged countries. And the resulting contingency plan of solutions would have the virtue of creating options and institutions for developing countries of the South in an essentially hostile world environment, without condemning them to inaction and stagnation. Economic change in their favour would be initiated through their collective self-reliance.

Nevertheless, only those aspects of collective self-reliance that benefit countries of the South individually as well as collectively should be promoted. In many cases, existing institutions are either inadequate or ill-adapted to bring about reconciliation between the individual and collective interests of countries of the South. However, institutional modifications and innovations that will enable the South to overcome such barriers to collective self-reliance are possible. To think of institutional change of such broad scope undoubtedly sounds utopian, although it is worth remembering that utopians at times become the greater realists as problems accumulate to unmanageable heights.

In this context, although the historical imperatives for South-South co-operation are recognized by most developing countries, the concrete steps by which it can proceed are not easy to establish. Indeed, many international documents (such as the Caracas Plan) emphasize the need for co-operation, without spelling out concrete details. It is here that we venture into relatively unexplored territory by trying to suggest concrete steps in the area of trade and finance.

Local currency repayment

A most unfortunate aspect of recent experience has been the sacrifice of the national goal of full employment in the face of high inflation and balance of payment problems in developed countries. This has not only imposed a heavy cost on the developed world in terms of lost potential output and demoralization of unemployed labour, but it has also inflicted a heavy burden on developing countries through economic interdependence. The latter have been faced with dwindling opportunities for expanding exports. The newly industrializing countries of the South have faced increasing demand constraints on the expansion of their manufactured exports, while the exporters of primary products, excluding oil, have suffered a deterioration in their terms of trade due to inadequate growth of demand under the inelastic supply conditions that characterize many

markets for primary products. Thus the sacrifice of the goal of full employment by developed countries has set in motion a chain reaction of depressive economic forces on a global scale.

It has been observed that "those who do not remember history are condemned to repeat it". A historical situation similar to the present indeed existed, following the return of the United Kingdom to an overvalued gold standard in 1925, on the eve of the great depression of the 1930s. It was the folly of that time to sacrifice national employment to balance-of-payments considerations (and a strong currency, as it is often described) which ultimately resulted in trade wars, international financial chaos and the greatest depression so far in this century. The Bretton Woods system established after the Second World War was negotiated primarily with that experience in mind. The fixed-exchange parities pegged to the dollar as well as institutional lending by the International Monetary Fund (IMF) to help deficit countries to tide over their temporary balance of payments problems were essentially ways of separating balance of payments problems from the national full employment objective. The disintegration of the Bretton Woods system also saw the gradual blurring of this separation. Today a situation has been reached where the full employment objective is almost consistently sacrificed by individual countries to maintain their balance of payments position. Its global repercussions have been a deterioration in world trade which adversely affects all trading partners. However, in a fundamental sense the global payments situation today is not significantly less viable than it was almost two decades ago. Until the early 1970s, the total trade deficits of the deficit countries (which algebraically equals the total trade surplus of the surplus countries except for the IMF "memorandum item") typically amounted to approximately 4 per cent of world exports. That deficit figure has gone up by about 1 percentage point in the early 1980s. This can hardly justify the claim that balance of payments problems have suddenly become overwhelming. Indeed, excluding the exceptional years of the first oil shock of 1974-1975, the ratio of trade deficits to the total value of trade has remained fairly steady around 4 per cent, once outstanding external debt servicing costs are excluded. This suggests a rule-of-thumb procedure by which approximately 4 per cent of the value of world trade may be extrapolated as the global deficit that must be met by some system of international payments, without jeopardizing global strategies to increase output, employment and trade over time.

Such a rule of international liquidity creation could be broadly applicable only if international debt and the servicing burden are not allowed to accumulate but are looked upon as necessary frictional elements in trade expansion. It is here that the present international payments system and the so-called recycling operation of the transnational banking system has turned out to be counter-productive in sustaining the growth of world trade over time. There can be no doubt that the enormous servicing burden of the accumulated debt of the South, particularly the newly industrializing, middle-income countries that mostly account for commercial debt, has meant a serious and steady leakage of effective demand from world trade. The repayment of debt, in so far as it decelerates the net inflow of foreign capital into developing countries (which has been a marked tendency in the last three years), naturally means a reduction in their international purchasing power both directly and indirectly through a lowering of domestic economic activity as a result of the so-called foreign exchange constraint. To the extent that debt repayment simply entails liquidation of financial liabilities by the debtor and neither involves recycling by banks to maintain net flows to developing countries nor leads to corresponding expansionary monetary or fiscal policies in the

creditor developed country, debt repayment could contribute to further curtailment of international demand, particularly demand for internationally traded goods. Consequently, the international payments system has to be revised and restructured because no rule of international liquidity creation will be compatible over time with such a one-sided accumulation of debt by any country or group of countries. The essence of the problem then is to maintain an international payments arrangement that is viable over time, without perpetual destabilizing tendencies arising from accumulated debt servicing costs.

The problem of a payments arrangement can be analytically explored with the help of computer simulations of the implications of various dynamic growth patterns in world output, employment and trade. In terms of the industrialization objectives set out in the Lima Declaration and Plan of Action, which called for 25 per cent of industrial value added to be produced in the South by the year 2000, it was found by means of various alternative simulations that an approximately 3 per cent annual growth rate in the gross domestic production of the North and an approximately 7 per cent growth rate in that of the South would produce a mutually sustainable pattern of growth in the world economy, entailing a nearly 9 per cent annual growth of industrial output in the South. A slower growth rate in the North would have negative feed-back on the pace of industrialization in the South through a slackening of world demand for traded goods. At the same time, any substantial reduction in the industrial growth rate of the South through lack of effective demand in world trade will tend to stifle progress towards the Lima target.

Consequently, both for purposes of illustration as well as an analysis of North-South co-operation, the above pattern of growth in the world economy may be used as the point of reference. Its associated trade pattern and the resulting deficits, under certain assumptions, would lie within the postulated total deficit limit of 4 per cent of the total value of export trade.

At the institutional level, international payments arrangements must be devised to meet that deficit over time, without setting in motion cumulative forces of disequilibrium that could destabilize, for example through mounting debt servicing costs, growth in world output and trade. We therefore propose the idea of settlement of balance of trade deficits in terms of local currencies. This rather simple idea has powerful implications which need elaboration both at the institutional and at the theoretical level.

A major institutional implication of the settlement of trade deficits in local currencies that the importance of international foreign exchange markets must be reduced. The existing international system of payment exclusively in hard currencies, where each dollar borrowed is repaid in dollars, entails that every such transaction must go through the foreign exchange markets. However, particularly since the breakdown of the Bretton Woods system, floating exchange rates have been subject to wide fluctuations largely caused by speculative capital flows against which no viable administrative measure on a global scale has been found. The uncertainty of fluctuations in exchange rates is transmitted to the existing hard-currency payments system, which government-to-government transactions in local currencies to settle trade deficits would largely avoid. From the point of view of containing currency speculation as a detrimental factor in international trade and investment, settlement in local currencies seems a more effective institutional arrangement than the market solution provided by spot and futures markets for foreign exchange, neither of which has proved to be immune to wild speculative fluctuations

in recent years. From an institutional point of view, settlement of trade deficits in local currencies also allows a greater administrative simplification. Much of the present elaborate system of international finance, including commercial bank lending to developing countries, is essentially a financial mechanism to transfer debt obligation. A country basically has the obligation to pay in terms of its future goods and services when it runs a deficit in trade. Denominating this debt in dollars or any other hard currency basically means the debt obligation is generalized and becomes a claim on the goods and services of a country. However, a bank which lends dollars to cover the deficit of a country is basically still accepting as collateral asset the obligation of the deficit country to pay in its future goods and services, so that in an interlinked system of assets and liabilities, the commitment of the deficit country to pay in its goods and services is its ultimate liability as collateral asset of the final lender in the chain. Local currency settlement avoids this vast and often counter-productive super-structure of international private financial institutions and fixes debt obligations directly on a bilateral basis.

The main analytical issue involved in the international settlement of trade deficits in local currencies therefore centres around weighing the disadvantages of a bilateral trade payments system against its many advantages. In so far as a surplus country is paid in local currencies and such payments are strictly conducted among central banks or similar monetary authorities, the choice of the surplus country is narrowed to goods and services of the deficit countries concerned. Such a loss in the economic welfare of the surplus country arising from a narrower range of choice has to be weighed against its three major advantages. First, an export surplus operating through the foreign trade multiplier allows the surplus country to maintain a high level of employment at home. Second, by tying trade deficits to local currency payments, claims are generated on goods and services of deficit countries which tend partially to redirect international demand in their favour and thus sets up self-regulating forces for maintenance of world demand in exports. Finally, it avoids the uncertainties of wild speculative movements in the foreign exchange market that cause exchange rates to fluctuate unpredictably, hampering growth in foreign trade and investment. In short, local currency settlement of trade deficits, while bestowing considerable advantages to a surplus country, imposes some cost in terms of continual surplus accumulation by restricting its choice of claims on future goods and services. One major failure of the Bretton Woods system and of the present arrangements is the lack of any automatic international mechanism to enforce adjustment on surplus countries, which results in an unmanageable accumulation of debts and structural deficits with longer-term destabilizing consequences for world trade. A system of settlement of trade deficits in local currencies, by enforcing adjustments on both the surplus and the deficit country, would in all probability be an improvement on earlier international payments systems.

Nevertheless, so long as the domestic price level in the deficit countries remains stable, the value of deficits denominated in local currencies reflects a well-defined purchasing power in terms of the claims on the future goods and services of the deficit countries. As mentioned above, a unique advantage of the settlement of trade deficits in local currencies is to tie together stability of the domestic price level with maintenance of effective demand through the foreign trade multiplier, an advantage that is altogether lost under the existing system of repayment which brings in the extraneous element of exchange rate fluctuations due to speculative international movements of hot money.

The nominal interest payment on local currency debt can therefore be generally ignored, unless the domestic price level is unstable in the deficit country. In the case of domestic price inflation, a compensatory interest payment in local currency is made, for example a 3 per cent rise in price level in the deficit country is compensated for by a 3 per cent "interest" payment, so that the real value of the debt in terms of claims on goods and services of the deficit country remains fixed. Obversely, a fall in the domestic price level must contain a premium in terms of negative interest rate. In effect, this maintains a zero real or own rate of interest in international payments on trade deficit accounts, which should be acceptable as the principle of transaction among central monetary authorities or central banks. Its added advantage is to reward price stability and penalize inflation in the deficit country through an automatic self-adjusting mechanism.

In terms of more conventional wisdom, it may be argued that such a local currency payment agreement would adversely affect the surplus countries, in so far as it restricts them to the use of such currency on a bilateral rather than a multilateral basis. In short, local currency debt is a bilateral and not a generalizable multilateral contract of payment by the deficit country. This argument, which undoubtedly lies also at the heart of the IMF practice of discouraging trade bilateralism in general, can be seen to be fundamentally flawed. Any surplus country gains in terms of domestic demand management through the working of the foreign trade multiplier. Hence the usual principle of over-compensation of the gainer by the loser in economic theory can be evoked to show that the surplus country is over-compensated irrespective of the form in which its trade surplus is repaid. Translated into more familiar terms, it points to the basic assymetry in the prevailing international payments system, where the entire burden of adjustment falls on the deficit country, unless, of course, its currency has the status of an international reserve currency. However, on grounds of both ability to bear cost and the benefit of high domestic employment derived from trade surplus, it is the surplus country which is in a better position to bear the burden of adjustment. A main justification of settlement of trade deficits in local currencies is to be found precisely here.

In order to prevent the destabilizing consequences of accumulation of local currency debt by a country in chronic trade deficit, local currency settlement has to be complemented by a ceiling rule operating both on debt volume and on the timing of the settlement. It needs to be recognized that local currency spending by the creditor country has a favourable output effect on the debtor country, so long as it has excess capacity for production and export. Very large-scale spending from accumulated debt held in local currency may, on the other hand, destabilize prices and create inflationary pressures in the debtor country. This can be avoided by putting a limit to such an accumulation of debt, for example a debt maximum in relation to the gross domestic production of the debtor, or by mutual agreement that unless the local currency debt is spent within a specified period of time, such as three years, the debt will be converted to a mere accounting settlement. Indeed, it is this idea which underlies various proposals for the conversion of the present debt of developing countries to long-term debt. Only by a frank recognition of the problem of structural deficits in international payments and by putting a ceiling on the level of accumulation of international debt as claims on goods and services of the debtor countries will the present international economic system be cured of its paralytic condition caused by the chronic deficits and surpluses in international payments.

A placement currency for the South

A globally accepted scheme of settlement of trade deficits in local currencies would be one of the most effective ways of combatting recession in the world economy. Indeed, the intrinsic difference between the so-called hard currencies of the countries of the North and the soft currencies of most countries of the South arises from the ability of the former to settle international payments in their domestic currencies. Free convertibility of a currency simply makes local currency settlement acceptable because the resulting debt is transferable through currency conversion. One of our central suggestions is to break this link - a link that has always been assumed in international financial arrangements - between currency convertibility and the medium of settlement of international payments on a bilateral basis. Contrary to the received wisdom of the IMF, it is maintained here that a general system of bilateral settlement of trade deficits in local currency would introduce a more effective and self-regulating mechanism for tackling the problem of international demand management and hence for sustaining steady expansion in world output and trade. It should be emphasized that in the present international perspective, demand management through local currency settlement of trade deficits would be especially appropriate. Although bilateralism in international payments is never an objective and may only be accepted as a temporary arrangement until an international clearing-house agreement on genuine multilateralism is established, the immediate problems facing the international economy concern an international perspective on demand management and rapid expansion in world trade. At least as a short-term device, the scheme of settling trade deficits in local currencies is clearly superior to the present international payments system that has produced violent depressionary forces in world output and trade.

Nevertheless, since it entails extending the privilege of hard currencies to soft currencies on an international scale, the system may be questioned and in all probability rejected by countries of the North. Under such circumstances, the countries of the South would have no option but to devise co-operation on a unilateral South-South basis. As a first step, local currency settlement of trade deficits among countries of the South could proceed in the above manner. But rough estimates suggest that not more than 30 per cent of the trade of the countries of the South is conducted among themselves. Hence the remaining 70 per cent of the trade of the countries of the South, including centrally planned economies, must be settled on a different financial basis, at least in so far as North-South trade is concerned.

To overcome this problem the South has no option but to fall back upon a scheme of collective self-reliance. A "placement" or common international currency could be agreed upon by countries of the South to settle part of North-South trade. Like any other investment or financial placement, although non-interest bearing, it would be basically designed to assume the character of a placement currency, in the hope that surplus countries would tend to hold it as a store of wealth, like dollar holdings by low-absorber countries of the Organization of Petroleum Exporting Countries, by Japan or by the Federal Republic of Germany. This would require building confidence in the placement value of the currency.

The common placement currency of the South would not be used in settling North-South trade. For example, oil could not be paid for by the North in the placement currency. It would perform one major function of money as a store of value and a unit of account, without the other major function as a medium of exchange of payment in North-South payment

arrangements. Nevertheless, to finance both intra-North trade and some imports from the South, the countries of the North might insist on the placement currency indirectly becoming a medium of exchange, without which the required international confidence in a common currency of the South would never be built. Thus some mechanisms must exist for liquidation, or conversion, of the placement currency in terms of currencies of the North. It is here that a joint-stock principle - a principle of limited liability - could be introduced among countries of the South. Partly because intra-South trade deficits would be settled in local currencies, and also because all countries currently have reserve holdings, every country of the South would have some foreign exchange-currencies of the North - to share the liability of liquidation of placement currency into Northern currencies. It is to be hoped that the surplus countries of the South would bear a larger proportionate share of the liability. The exact sharing of the liability could be determined through intra-South negotiations. A placement currency of the South, internationally floated on the principle of limited national liability for each country of the South, could be a powerful demonstration of the principle of collective self-reliance, even in a hostile international financial environment that could be created by the refusal of the North to co-operate. South-South financial co-operation could indeed begin with the following two essential steps: a settlement of intra-South trade deficits in local currencies; and floating of a common placement currency on the principle of limited liability of each country of the South.

TRENDS IN UNITED STATES MANUFACTURING INDUSTRY AND THEIR POSSIBLE IMPLICATIONS FOR LATIN AMERICAN INDUSTRIALIZATION: CASE STUDIES OF STEEL, ELECTRONICS AND PETROCHEMICALS

Peter B. Evans*

Introduction

The principal aim of this report is to examine the recent changes in United States manufacturing and how such trends are likely to affect the prospects of Latin American countries endeavouring to industrialize in the face of the current condition of the global economy. The main vehicle for the analysis is a set of three case studies of specific industries: steel, electronics and petrochemicals. Steel is an industry which is clearly declining in the United States and facing difficult problems of over-capacity world-wide. Electronics is an example of an industry in which the United States is likely to place substantial hopes for the future. Petrochemicals is an intermediate case, one in which the comparative advantage of the United States is likely to erode, at least in important segments of the industry, but which is currently a strong competitor internationally.

Current United States industrial policy seems to have been shaped by the combination of three factors. First, the commitment to the predominance of market forces in economic activities has limited an active governmental role in industrial development and in directing structural adjustment. Secondly, the social and economic problems caused by the declining international competitiveness of basic United States industries have created growing pressures for protectionism. Thirdly, the interest of United States-based transnational corporations in the maintenance of an open international economy has created similar pressures against systematic protectionism. In combination, these factors have produced a policy which has allowed the growth of manufactured imports from Latin America while encouraging the growth of United States direct investment, but has also erected tariff and non-tariff barriers against Latin American manufacturers in a number of industries while failing to provide relief to United States communities and workers in declining industries.

Continuation of current United States policy to respond on an *ad hoc* basis to these conflicting pressures seems to be the most likely prospect for the future, but three other possibilities must also be considered. None of these is likely to emerge as an alternative in itself; nonetheless, each represents a direction in which current policy might be modified.

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One possible alternative is active retardation of structural change. This possibility is attractive from the point of view of labour displaced from traditional industries by technological change and shifts in international competition. It may also be attractive to domestic capital in that it provides relief without implying extensive government involvement in the allocation or management of industrial capital. It is, nonetheless, unlikely to dominate United States industrial policies both because of the high welfare costs involved and because of its strong negative consequences for transnational corporations.

A second possibility is positive adjustment focused primarily on achieving increased competitiveness in international markets. This would involve relaxing current attempts to shield "sunset" industries while actively promoting and subsidizing the growth of "sunrise" industries. Increased governmental support for research and development of new technologies is a part of current policies to foster growth in new areas of comparative advantage. Active export promotion would be one of the hallmarks of such a policy and it therefore might be called "nationalist accelerated adjustment".

The final alternative might be called "internationalist accelerated adjustment". Like a nationalist variety of accelerated adjustment, it would involve active governmental efforts to shift the sectoral profile of United States industry, but the major emphasis of such policy would not be on export promotion as such. Export promotion can lessen domestic balance-of-payments problems while increasing those of its trading partners. An "internationalist" industrial policy, on the other hand, would attempt to solve United States economic problems without disrupting the industrial growth of other nations. It would have to focus primarily on using domestic resources, especially labour, more effectively rather than concentrating on balance-of-payments problems. This would entail significant public support in the reallocation of domestic capital, both among industries and among activities within industries, and much more public attention to the functioning of domestic labour markets.

Policies in a number of domestic and external affairs would be crucial for increasing the capacity for structural adjustment in the framework of an internationalist accelerated adjustment strategy. Greater assistance would be required in retraining or relocating workers and in easing the transition for communities to new productive activities so that the burden of shrinking industries does not fall disproportionately on a few. Moreover, greater attention would have to be given to the effects of fiscal, monetary and technological innovation policies, as well as trade régimes, on the industrialization efforts of developing countries, as these effects are very significant given the level of interdependence in the global economy.

For example, United States monetary and budget financing policies have a large impact on the debt repayment efforts of Latin American countries. According to the Bank for International Settlements, a 1 per cent rise in dollar interest rates is estimated to increase interest payments of the six largest Latin American countries by $1,533 million ($187 million for Argentina, $521 million for Mexico, $577 million for Brazil). This single increment of increased debt servicing would be equivalent to a 4.0 per cent cut-back in imports in Argentina, 5.2 per cent in Mexico, 3.6 per cent in Brazil, or an increased trade surplus of the same magnitude. This demonstrates the crucial linkages between developing countries' debt and their exports to and imports from the United States – most importantly of manufactured goods.

Policies influencing the development and transfer of technology are another key issue as changes in processsing techniques and new products in the United States can greatly affect the industrial co-operation between the United States and Latin American countries. In order to build viable and competitive industrial structures and utilize technical innovations in upgrading production, Latin America would need to monitor technology developments in the United States. This in turn presupposes transparency in United States policies for funding research and development efforts and overseeing trends in intra-firm and other technology transfers. United States policy may require additional incentives to encourage firms to centre growth strategies more on the benefits of exporting technologies to the growing markets in developing countries (such as extending life cycles of technologies and recouping research and development costs) than on merely controlling and restricting the dissemination of technologies. In connection with the debt problem, resolving the economic and financial problems in Latin America would go a long way to increase the attractiveness of investment in and redeployment of production facilities to Latin America.

United States industrial policy affects all developing countries, but its effects are particularly great in Latin America. While East Asian newly industrializing countries have played a more cental role in the increased United States consumption of manufactures from developing countries, economic ties between the United States and Latin America are more intimate and complex, first of all because of the greater role of United States transnational corporations in Latin American manufacturing and, secondly, because of the greater interconnection of the Latin American and United States labour markets (via immigration).

The way in which these policy tendencies are blended to form future United States industrial policy is obviously of crucial importance to Latin America. Continuation of current United States policies would probably not enhance Latin America's prospects for industrialization. A movement in the direction of active retardation of structural change would force a fundamental rethinking of current Latin American industrialization strategies. Such a rethinking could in turn have negative effects on the international position of United States manufacturing. It must be remembered that without its trade in manufactures with Latin America, the United States would have had a negative balance of almost $12 billion in 1979 instead of a positive balance of over $5 billion.

Steel: United States decline and Latin American expansion in a basic industry

The United States steel industry's comparative advantage disappeared over the course of the 1950s and 1960s and it was confronted with economic disaster in the late 1970s and early 1980s. Shrinking demand coupled with competition from more efficient foreign producers created massive losses for the companies involved and tens of thousands unemployed steel workers. As Latin American steel industries began to face growing overcapacity in the beginning of the 1980s, steel became a matter of contention in United States/Latin American relations.

World over-capacity and the changing international division of labour in steel

At the end of the 1950s the United States still dominated the world steel industry. United States capacity was double that of the European

Steel Community and five times that of Japan (Crandall [1], p. 143). Even though United States steel companies focused their attention almost exclusively on the domestic market, the United States exported three times as much steel as it imported (see table 1). Steel workers earned wages that were about 50 per cent higher than the average wage in United States manufacturing (see table 5) and while rates of return varied substantially from company to company, even the larger and less efficient United States firms were able to protect their profits through "administered pricing". But the United States industry's "golden age" was already over and the industry was in the process of being restructured internationally.

Table 1. Evolution of United States steel production, 1956-1981
(Millions of tonnes a year)

	1956	1966	1972	1978	1981
Capacity	129.9	149.4	156.2	156.0	..
Production	115.2	134.1	133.2	137.0	122.0
Exports a/	4.2	1.7	2.9	2.4	2.8
Imports a/	1.3	10.8	17.7	21.1	18.0
World production	313.4	521.1	694.6	790.6	..

Sources: Robert Crandall, The United States Steel Industry in Recurrent Crisis: Policy Options in a Competitive World (Washington, D.C., Brookings Institution, 1981), pp. 24-25; for United States production and trade, 1981, United States Department of Commerce, 1982 United States Industrial Outlook for 200 Industries with Projections for 1986 (Washington, D.C., 1982), p. 153.

a/ Steel mill products.

International competition and trade tensions

The principal challenge to the United States position in steel came from Japan. Japanese capacity, which was 10 per cent of United States capacity in 1956, had doubled by 1960. Japanese exports reached the level of United States exports by the early 1960s and then began to accelerate dramatically. By 1978, Japan had increased its capacity over five-fold from 1960 levels, surpassing United States capacity. Its exports had grown even more rapidly until it was the world's largest exporter with exports 50 per cent greater than those of its nearest rival, the Federal Republic of Germany, and 10 times greater than those of the United States (Crandall [2], pp. 26-27). European steel also expanded dramatically over the 1960s and 1970s, more than doubling over 1960 levels until combined European capacity also exceeded that of the United States (Crandall [1], p. 143).

World-wide demand for steel essentially stopped growing in 1973. Substantial declines between 1973 and 1974 could be attributed to the oil shock, and in the late 1970s it appeared that demand might catch up with capacity by 1985 (see Kono [3], p. 79). The deterioration of demand in the early 1980s made it clear, however, that the problem of over-capacity was likely to be chronic. In the United States, production for 1981 was already heading back to the depressed levels of 1975, and 1982 was much worse than 1981. The Japanese domestic market recovered from its mid-1970s decline, leaving it to absorb an output equivalent to less than 50 per cent of domestic capacity.

Construction of new capacity stopped in the members of the Organisation for Economic Co-operation and Development (OECD), but it was too late. Europe tried unsuccessfully to solve the problem by eliminating inefficient capacity and allocating production. Both Europe and Japan looked to increased exports as a way of alleviating the problem. In Japan exports rose from 28 per cent of total production in 1973 to over 50 per cent of local production in the late 1970s. The United States, with high production costs and no tradition of competing in export markets, did not have this option. Even worse, the United States, while no longer the world's largest producer, was still the world's largest market and therefore a natural target for the export drives of other producers. The tendency of United States producers to attribute their problem to "unfair foreign competition", which had begun with increased import penetration in the 1960s, intensified in the 1970s and 1980s.

Changing position of developing countries

During the 1960s and the 1970s, the growth of demand for steel in the developing countries was the most dynamic component of the world market. This was particularly true in the period after 1973. While demand for steel in industrialized countries shrank at a rate of 2.9 per cent per year from 1973 to 1978, demand by developing countries increased at a rate of 8.9 per cent, (Kono [3], p. 77). Production by developing countries grew even more rapidly than it had done between 1960 and 1973, and capacity grew more rapidly still ([4], p. 3). Latin America was a principal locus of third-world steel production. Latin America's output grew from 13 to 24 million tonnes between 1970 and 1978 (see table 2), and in 1980 Latin America accounted for almost 50 per cent of developing country capacity (see table 3). Despite the growth of their capacity, developing countries continued to increase their imports of steel throughout the period. In 1981 the total gap between developing countries' production and consumption was just under 45 million tonnes ([5], pp. 14-15). Latin American demand provided the single most important market for United States exports. In 1980, Latin America accounted for 47 per cent of United States steel exports, importing about three times as much steel from the United States as it exported to the United States (see table 4).

Although Latin America has been more important as a market for United States steel producers than as a competitor, there has been a tendency to view the growth of steel capacity in Latin America and in the third world in general as a threat to United States economic vitality. The National Foreign Assessment Center (a subdivision of the United States Central Intelligence Agency) concluded its analysis of the "burgeoning developing country steel industry" by saying, "The growth of developing country steel-making capacity is adding to the already serious problems of the developed country steel industries" ([4], p. 8).

Table 2. Steel production in Latin America 1970-1978
(Thousands of tonnes a year)

Country	1970	1973	1978
Brazil	5 390	7 150	12 107
Mexico	3 881	4 760	6 775
Argentina	1 823	2 205	2 786
Venezuela	927	1 063	859
Other countries	1 160	1 509	1 432
Total	13 181	16 687	23 959

Source: James Wilkie and Stephen Haber, eds., Statistical Abstract of Latin America, vol. 21 (Los Angeles, UCLA Latin American Center Publications, University of California, 1981), p. 227.

Table 3. Steel-making capacity of developing countries: projections to 1990
(Millions of tonnes)

Region or grouping	1980 capacity	1990 capacity	
		Low growth a/	Expected growth b/
Latin America	35	63	82
Asia	34	56	76
Other developing countries	7	20	35
Total	76	139	193

Source: United Nations Industrial Development Organization, "1990 scenarios for the iron and steel industry: Addendum: the dossiers," Third Consultation on the Iron and Steel Industry (ID/WG.374/2/Add.1), pp. 34 and 38.

a/ Assumes cancellation of projects currently planned.

b/ Assumes completion of projects currently planned.

Table 4. Regional distribution of United States steel imports and exports: steel mill products, 1980
(Thousands of tonnes)

Region	Exports		Imports	
	Percentage	Amount a/	Percentage	Amount a/
Latin America	47.2	1 935	4.1	636
Asia (including Japan)	20.8	853	46.3	7 161
Africa	6.1	205	2.8	434
Canada	11.6	476	15.3	2 372
Europe	10.7	439	26.4	4 092
Other	6.1	250	3.6	558
Total	100.0	4 100	100.0	15 500

Sources: United States International Trade Commission, Certain Steel Products from Belgium, Brazil, France, Italy, Luxembourg, The Netherlands, Romania, The United Kingdom, and West Germany, vol. 1, USITC Publication 1221 (Washington, D.C., 1982), pp. 1-24 and 25; United States Department of Commerce, 1982 United States Industrial Outlook for 200 Industries with Projections for 1986 (Washington, D.C., 1982), p. 153.

a/ Calculated by taking total amounts of exports and imports from United States Department of Commerce and multiplying by percentage provided by the United States International Trade Commission.

If the steel-making capacity of developing countries is already seen as a threat, it is likely to become even more worrying over the next 10 years. If the steelmaking projects on the books as of the beginning of the 1980s are completed, Latin America's capacity will more than double by 1990, and overall developing country capacity will increase two and a half times (see table 3); [5]. Even under the assumption that some projects will be dropped, Latin American and overall third world capacity will still come close to doubling. Under a reasonable range of assumptions concerning third world production and demand, developing countries will increase their need for exports and Latin America's net imports will remain about constant ([5], pp. 39 and 53; [6], p. 97). Should the difficult times of the last two or three years, 1980-1982, continue, however, the development of both Latin American capacity and Latin American markets may be in jeopardy. One element in determining the future evolution of the Latin American steel industry will be the response of the United States to its own declining international competitiveness in steel.

Declining United States competitiveness

In the early 1950s the United States industry was not only dominant in terms of its size, it also had a very favourable cost structure. While wages were high in the United States, costs of raw materials were low. The cost of coking coal in 1956 was less than half Japanese costs; the differential in iron ore costs was almost as great. For the rest of the 1950s and throughout the 1960s, international prices for coking coal and iron ore declined, while United States prices remained the same or rose, until by 1972 it was Japan and not the United States which had the raw materials cost advantage (Crandall [2], p. 21).

Even more important in the erosion of the United States competitive position was the failure to modernize capacity during the 1950s and early 1960s when companies had the cash flow necessary to construct new capacity. To begin with, the United States built a much smaller amount of new capacity in proportion to existing capacity than did the Japanese or the Europeans. More seriously, the new capacity that was built was technologically outmoded. United States firms constructed 40 million tonnes of open hearth capacity during the 1950s when the overwhelming cost advantage of the basic oxygen process should have been clear. Even as late as 1963 only smaller United States firms had made a serious commitment to the basic oxygen process. The largest firms had no basic oxygen capacity at all (Adams and Dirlan [7], pp. 183 and 185). The response of United States firms to other technological innovations, such as continuous casting, has been equally slow (see Volk [8]).

Even though wages in Japan and other major steel-producing countries have risen more rapidly than wages in the United States steel industry, the United States still has no advantage in terms of labour costs. Lack of technological change in the industry has meant that value added per worker has grown more slowly than in United States manufacturing overall. At the same time, the strength of labour organization in the steel industry has contributed to more rapid wage increases than in other United States manufacturing industries. By 1977, steel workers were producing only $2.60 of value added for each dollar of wages received, while the average United States manufacturing worker produced $3.90 for each dollar of wages received (see table 5). As long as they continue to work in aging, inefficient plants, United States steel workers could only become competitive by drastically slashing their real wages, and since the companies for which they work have not directed profits toward productivity-enhancing innovations in the past, the willingness of steel workers to accept such a sacrifice would seem very unlikely.

Without a major renovation of United States plants, United States steel will not generally be competitive on international markets. By 1976 Japanese production costs were about 70 per cent of United States production costs for most major product classes (Crandall [2], pp. 171-172). There is little possibility for major renovations. With capital costs of a new greenfield facility estimated at almost $1,000 per tonne, and the capital costs of existing facilities having been largely written off, capital charges make production on new greenfield sites uneconomic. According to Crandall ([2], p. 152), "The cost of producing steel in new plants in the United States would be higher than cost of production in most existing plants".

The negative future prospects of the industry should not be exaggerated. The most efficient United States steel mills in the Great Lakes region are likely to remain competitive with foreign imports, even without substantial protection. Production in electric-furnace mini-mills in the south-east is growing relatively rapidly. Even if plants in the northeast and the Ohio River Valley are forced out of business, the overall reduction in United States steel capacity is unlikely to exceed 10 per cent (Crandall [2], pp. 146-147). From the point of view of overall economic and social welfare, the decline of the United States steel industry that might result from exposing it more fully to the forces of international competition does not seem catastrophic. From the point of view of those who live in the Monongahela and Mahoning valleys and other affected areas, however, the decline of the steel industry is already a catastrophy in the absence of an industrial policy that might speak to their distress.

United States industrial policy in steel

In a recent study, Franko [9] has identified the characteristics of those industries most likely to successfully seek protection from international competition. In addition to noting the obvious characteristic of being at a competitive disadvantage internationally, he emphasizes the overall magnitude of employment in the industry and the extent to which the firms in the industry are not diversified, either geographically or in terms of product markets. On both counts the steel industry is a likely candidate for a successful protectionist campaign.

Positions of firms and labour

Companies in the United States steel industry never became truly multinational. Among large United States firms, they stand out in their lack of overseas manufacturing investments. Not only have they focused their attention on the domestic market, but within that market they developed very early on a relatively stable pattern of oligopolistic co-operation. The largest firm in the United States, but by no means the lowest cost producer, provided "price leadership", and smaller, more efficient firms were able to earn substantial profits under its umbrella.

In contrast to the extensive State involvement in the steel industry that characterizes most countries, the United States Government exercised little initiative with regard to the development of the industry. The Kennedy and Johnson administrations tried to persuade the industry to abandon what they felt were unjustified price increases in the early 1960s, but there was no concerted attempt to increase the degree of technological change.

Some of the sharpest struggles in the history of the United States labour movement led to the creation of the United Steel Workers of America (USWA), which has remained one of the country's most powerful industrial unions despite the decline of the industry. During the period of United States dominance, steel workers benefited from the fact that the companies were confident of their ability to pass on wage increases to their customers. Even so, the industry witnessed several long and bitter strikes. The rise of import penetration during these strikes convinced management and the union that more co-operation was necessary. In 1973 an Experimental Negotiating Agreement, which limited the right to strike, was accepted by the union in return for wage concessions from management. Under this agreement, steel workers' wages continued to rise more rapidly than those of other manufacturing workers, despite the declining competitiveness of the industry (see table 5).

The protectionist response to international competition

The internal structure of the United States industry contained no dynamic that might have led to major change. The major firms had worked out a *modus vivendi* among themselves and with their union, which involved little innovation, little price competition, and generous wage settlements. The United States Government assumed no active role to promote adjustment policies, despite some concern on the part of Congress with the performance of the industry. Consequently, when the changes that were occurring in the industry internationally began to impinge on the United States market, the response was not an attempt to create a policy of positive adjustment but rather an attempt to insulate the industry from the pressure for change.

Table 5. Wages and value added in steel and United States manufacturing overall, 1960-1977
(Dollars)

Year	Steel			All manufacturing		
	Value added per production-worker hour (1)	Hourly wages (production-worker) (2)	Ratio of (1) to (2)	Value added per production-worker hour (1)	Hourly wages (production-worker) (2)	Ratio of (1) to (2)
1960	8.23	3.08	2.7	6.80	2.26	3.0
1970	11.37	4.22	2.7	11.30	3.35	3.4
1977	22.49	8.67	2.6	21.90	5.68	3.9

Source: United States Congress, Office of Technology Assessment, United States Industrial Competitiveness: A Comparison of Steel, Electronics and Automobiles, OTA-ISC-135 (Washington, D.C., Government Printing Office, 1981), pp. 55 and 59.

In 1968, hedging in preparation for a strike brought imports to an all-time high of 18 million tonnes. The industry called for protection and the United States Government responded by negotiating voluntary restraint agreements (VRAs) with Japan and the European Community. These remained in effect until 1975 and the tide of imports was stemmed. By 1977, after only one year without the umbrella of the VRAs, the industry was in trouble again. Plants started closing, one small company went bankrupt, and the president of USWA claimed that 60,000 steel workers had lost their jobs because of imports (New York Times, 7 October 1977, p. D8). Corporate losses mounted and political pressure mounted with it. A "Steel Caucus" was formed in the United States Congress, which included 25 per cent of the members of the House of Representatives and 20 per cent of the Senate.

The Carter Administration responded with a "Comprehensive Program for the Steel Industry", known as the "Solomon Plan" ([10], pp. 3-38). The "Comprehensive Plan" included proposals for loan guarantees from the Economic Development Administration for companies trying to modernize, some assistance to affected communities, relaxation of legal impediments to mergers and to co-operation among companies on research and development, and a "rationalization" of environmental protection regulations. The task force that produced the plan remained convinced that the Government's response "must avoid any direct government involvement in the industry's decision" ([10], p. 11). Consequently, the key-stone of the plan was increased protection.

The Plan introduced the trigger price mechanism (TPM) as a means of protecting the domestic industry from "unfair competition" from abroad. The very stringent "anti-dumping" provision contained in the 1974 Trade Act was already in effect, but the TPM gave the steel industry special relief from the difficulties of enforcing this provision. Instead of requiring an investigation to determine whether a given foreign producer was selling at less than fair market value, the TPM allowed claims of dumping to be processed for any imports sold at below "the full costs of production including appropriate capital charges of steel mill products by the most efficient foreign producers (currently the Japanese steel industry)" ([10], p. 16). The TPM was of dubious legality according to traditional international definitions of "dumping" (Schneider [11]). It also proved ineffective economically.

According to the Comprehensive Plan, the protection provided by the TPM, along with certain favourable changes in the tax laws, would provide the industry with the capital necessary to modernize and become more competitive internationally ([10], pp. 24-27). In hindsight, this can be seen as an unrealistic prediction. By the beginning of 1982, with United States steel firms operating at only 55 per cent capacity and on their way to even lower levels, and the Administration unable to negotiate an agreement with the Europeans to limit exports, United States companies filed a record 110 anti-dumping and countervailing duty actions and the Government suspended the TPM response. The TPM did raise domestic steel prices while it was in effect, thus transferring resources from consumers to producers of steel. Crandall estimates the cost to consumers at about $1 billion a year for 1978-1979 and the number of jobs saved at 12,400 (Crandall [2], p. 139). As an industrial policy designed to help the steel industry adjust to changes in the international economy, its effectiveness was quite limited.

Possible policy outcomes

There is little likelihood of any policy of positive adjustment for the steel industry being instituted in the short or medium run. Consequently, the most probable policy outcome is a continuation of what might be called "ad hoc" protectionism. Steel companies are likely to continue to accuse foreign producers of dumping and the United States Government is likely to continue to try to negotiate export restraints with the Japanese and European Governments. Whether any more stringent protection against steel imports is in the offing is less clear. The industry would probably like to impose quotas (see Fortune, 8 February 1982, p. 47), and the possibility that Congress would support more extensive forms of protectionism cannot be excluded.

The possibility of alternative policies, low as the probability of their implementation may be, should at least be noted. The case of a works in Youngstown, Ohio, serves as a useful illustration. When its conglomerate owner shut down the works in 1977, over 4,000 steel workers were without work and the effects on the community were devastating. A community group put together a proposal for reopening the plant as a community-owned corporation. They planned to modernize the plant and to produce from scrap rather than ore, a reasonable idea for a steel works located in the middle of the "scrap belt". The reopened plant would have been able to employ 3,600 workers. The workers would have taken stock in the company in lieu of incentive pay and would have agreed to a number of changes in work rules, not an unreasonable bargain given that they would have had considerable control over the operation of the company. Worker concessions would have reduced labour costs by over 20 per cent (see Kotz [12]).

In order to be implemented, the Youngstown plan would have required a $245 million loan guarantee from the Economic Development Administration. The executives of the major steel companies lobbied against the plan, and support by union officials was limited in concern over its effects on collective bargaining. The Economic Development Administration turned down the request for a loan guarantee and the idea was aborted. It remains, none the less, an example of how a more imaginative approach to restructuring might succeed in rescuing distressed communities and redirecting political pressure away from a focus on protectionism.

Implications for Latin American manufacturing

Since United States companies have not invested in steel-making facilities in Latin America, questions of investment policy and behaviour by transnational corporations are not central issues in the steel industry. The effects of United States industrial policy are felt primarily through its impact on trade, more specifically through the intensification of United States protectionist efforts in the steel industry. Brazil, which produces over 50 per cent of Latin America's steel (see table 2) and has recently expanded its steel exports to the United States, has been the major target, but other countries in the region which for different reasons may have long-run comparative advantage in steel production, are likely to see future implications in Brazil's current problems.

The maturation of the Latin American steel industry

The growth of steel-making capacity in Latin America and the third world in general has been noted. It is equally important to note that the

steel capacity being created in Latin America and the third world generally is technologically competitive with existing capacity in the United States. Crandall estimates that costs of production at a new greenfield site in Latin America are lower than those of a similar facility in the United States (see table 6). Obviously, existing United States plants benefit from the high capital charges forced on new facilities by current capital costs, and may have lower costs than new Latin American facilities (though not necessarily new Asian facilities). By the same token, however, once new plants are built, marginal rather than average costs are likely to be the basis for pricing, especially in times of slack demand.

Table 6. Cost comparison for new steel facilities in United States and Latin America, 1978
(Dollars per finished tonne of flat-rolled carbon steel)

Item	United States	Latin America
Labour	88	35
Raw materials and miscellaneous	176	176
Capital charges	161	200
Total	425	411

Source: Robert Crandall, The United States Steel Industry in Recurrent Crisis: Policy Options in a Competitive World (Washington, D.C., Brookings Institution, 1981), p. 91.

Note: The figures are based on the following assumptions:

	United States	Latin America
Man-hours per tonne	6	10
Hourly wage	$14.69	$3.50
Construction cost per tonne	$937.50	$1 000.00
Capital charge	$0.172	$0.20

Third-world countries have benefited from the global dispersion of steel-making technology, and they are likely to benefit even further as additional new capacity comes on stream. Third world countries are pushing ahead with new direct reduction processes of steel making while industrialized countries are not. In Brazil the percentage of steel production using continuous casting was already one and a half times the percentage for the United States industry as of 1979 ([6], pp. 12-17 and 124). When the technological evolution of Latin American steel industries is combined with certain raw materials advantages, for example, Brazil's massive supply of high quality iron ore or Mexico's supplies of energy, the possibility of these countries having a long-run comparative advantage in the export of steel is hard to deny. In the short run, however, the development of the steel industries in these countries has been severely threatened by problems in both international and domestic markets. These problems are perhaps best exemplified by the case of Brazil.

Current difficulties in the Latin American steel industry: the case of Brazil

In 1981, Brazilian steel production, which had grown exuberantly up to that time, dropped by 14 per cent relative to 1980. Brazil, which had traditionally lacked local capacity sufficient to meet domestic demand, suddenly had almost 5 million tonnes of excess capacity. In 1982 production declined even more rapidly. Several of Brazil's most ambitious steel projects were in serious jeopardy. Aconimas, projected to produce 2 million tonnes of steel a year and supply the construction industry with structural steel previously unavailable on the local market, threatened to become "the most expensive scrap yard in the world" (Latin America Weekly Report, 5 November 1982, p. 11). Plagued by delays and difficulties in raising capital, the project was becoming hard to justify. Tuberao, Usiminas, and other large projects were also experiencing difficulties. Vibasa, the country's newest producer of speciality steel, has been operating at less than 50 per cent capacity since it came on stream in 1980.

The problems of Brazil's steel industry are principally due to the collapse of domestic demand caused by the deep recession that has plagued the industrial sector for the past two years. There is, however, an international component to the problem. When Brazil formulated its plans for expanding local capacity to 28 million tonnes a year by 1985 it was counting on rapid growth of domestic demand, but it was also counting on eventually exporting 10 million tonnes of steel a year. When domestic demand fell in 1980 and 1981, Brazil's need to export increased significantly. At this point, however, it ran directly into the problem of increasing United States protectionism.

Between 1979 and 1980, Brazil's exports of carbon steel plate to the United States more than doubled. Its exports of stainless steel bar doubled between 1979 and 1981, and its exports of stainless steel wire rod went from nothing to 28 per cent of total Brazilian production (see table 7). In 1981 the United States market absorbed 68 per cent of all Brazilian exports of carbon steel plate, 79 per cent of all Brazilian exports of stainless steel wire rod, and about half of all Brazilian exports of stainless steel bar. The next year, the United States International Trade Commission (USITC) and the United States Department of Commerce, acting on complaints from domestic producers, investigated these imports and USITC found "reasonable indication of material injury or threat thereof" ([13], p. 22; [14], p. 20). Brazilian steel producers were found to be the beneficiaries of "countervailable subsidies", principally rebates for exports of the Industrial Products Tax ([14], p. A-5). Steel had become a central issue in the longstanding dispute between the United States and Brazil over the legitimacy of Brazil's export incentives in general and the rebates of the Industrial Products Tax in particular, and Brazil's attempts to salvage the development of its steel industry on the basis of an export-oriented strategy were clearly in difficulty.

The eventual outcome of this confrontation is still unclear. Brazil has promised to phase out Industrial Products Tax export rebates as a general practice, but intends to allow rebates in certain specific cases (Latin America Weekly Report, 24 September 1982, p. 8). It also intends to retain the substantial export subsidies organized under the BEFIEX programme (Business Latin America, 15 September 1982). If these subsidies are in fact continued, it remains to be seen whether the United States will impose countervailing duties, as it has done in other cases. If the incentives are withdrawn, perhaps in the context of a "maxi-devaluation"

Table 7. Growth of selected Brazilian steel exports to the United States, 1979-1981
(Thousands of tonnes)

Type of export		1979	1980	1981
Carbon steel plate				
Brazilian production		1 500	1 800	..
Exports:	To United States	177	389	..
	To EEC	19	46	..
	Other	128	140	..
	Total	324	575	..
Exports to United States as a percentage of Brazilian production		12	22	..
Stainless steel bar				
Brazilian production		16.7	28.9	27.4
Exports:	To United States	1.4	2.0	2.9
	To EEC	4.1	3.9	2.9
	Other	0.9	-	-
Exports to United States as a percentage of Brazilian production		8	7	11
Stainless steel wire rod				
Brazilian production		3.2	4.1	5.3
Exports:	To United States	0.0	0.02	1.5
	To EEC	0.6	0.6	0.4
	Other	0.1	0.2	0.0
	Total	0.7	0.82	1.9
Exports to United States as a percentage of Brazilian production		-	-	28

Sources: For carbon steel plate, United States International Trade Commission, Certain Steel Products from Belgium, Brazil, France, Italy, Luxembourg, the Netherlands, Romania, the United Kingdom, and West Germany, vol. I, USITC Publication 1221 (Washington, D.C., 1982), p. II.23; and for stainless steel bar and stainless steel wire rod, United States International Trade Commission, Hot-Rolled Stainless Steel Bar, Cole-Formed Stainless Steel Bar, and Stainless Steel Wire Rod from Brazil, USITC Publication 1276 (Washington, D.C., 1982), p. A-42.

as in 1979, it is possible that Brazilian steel might still be able to penetrate the United States market, in which case the United States response again remains in question.

Whatever the eventual outcome, one thing is clear for Brazil, as well as for other would-be Latin American steel exporters: if they try to link the development of their steel industries to the possibility of exporting to the North American market, they will not face a welcome reception as long as the international market for steel and United States policy toward the steel industry continue on their current courses.

Petrochemicals: responses to the changing international division of labour in a dynamic industry

Petrochemicals stand in sharp contrast to steel, both in terms of the dynamism of the industry world-wide and in terms of the position of the United States within the industry. Growth of demand for most petrochemicals was over 10 per cent per year world-wide between 1975 and 1979, and growth of demand for thermoplastic resins was even more rapid. United States exports were also growing, and the magnitude of exports continued to be several times greater than that of imports. In other respects, however, there are important similarities between steel and petrochemicals. In petrochemicals, as in steel, the growth of demand, production and capacity have been most rapid in developing countries and are likely to continue to be in the future. United States cost advantages in petrochemicals appear to be eroding, as they did in steel. In addition, the early 1980s have seen problems of over-capacity beginning to emerge in certain sectors of the petrochemical industry. It would be an exaggeration to suggest that the petrochemical industry of the 1990s will resemble the steel industry of the 1970s. Continued product innovation, especially downstream, is likely to keep the industry dynamic for some time. There is also a fundamental difference in the organization of the industry which is not likely to be erased over time. Unlike steel, petrochemicals is dominated by firms, the major oil and chemical multinationals, that are pre-eminently global in their interests and strategies.

The current and future United States position in petrochemicals

Growth of the world market

Petrochemicals has been the fastest growing segment of the chemical industry, which in turn has been one of the most dynamic sectors in the economies of the industrialized nations since the Second World War. World exports have grown even faster than the industry overall. The volume of world plastics exports, for example, increased 76-fold between 1950 and 1970 ([15] p. 13). These rapid rates of growth were based on a combination of relatively high rates of gross national product (GNP) growth in industrialized countries, liberalization of international trade, cost-cutting technological developments in the industry and falling real prices for oil. The growth rates of the 1950s and 1960s were not achieved in the 1970s and will not be achieved in the 1980s. Nonetheless, as table 8 indicates, the growth of demand over the course of the 1980s is still likely to be much more rapid than projected GNP growth rates in industrialized countries.

Table 8. Growth of world petrochemical demand, selected major products, (1975-1990)

Economic grouping	Ethylene	Thermo-plastic resins a/	Synthetic fibres b/	Synthetic rubbers c/
		Millions of tonnes		
Demand, 1975:				
Industrialized countries	23.35	21.32	5.51	4.32
Developing countries	1.15	3.28	1.56	0.54
World d/	24.50	24.60	7.07	4.77
Demand, 1990:				
Industrialized countries	56.50	58.0	10.02	7.97
Developing countries	13.95	22.0	5.10	1.98
World d/	70.45	80.0	15.12	9.95
		Percentage per year		
Growth, 1975-1979:				
Industrialized countries	10.4	12.6	8.1	6.6
Developing countries	24.0	19.6	11.9	14.1
World d/	11.2	13.6	9.0	7.5
Growth, 1979-1984:				
Industrialized countries	5.8	4.8	3.0	3.9
Developing countries	17.6	11.7	7.4	8.7
World d/	6.2	6.1	4.1	5.8
Growth 1984-1990:				
Industrialized countries	4.3	5.0	3.2	3.1
Developing countries	14.9	11.1	6.4	5.9
World d/	6.0	6.4	3.5	3.6

Source: United Nations Industrial Development Organization, "Second world-wide study on the petrochemical industry: process of restructuring", Second Consultation on the Petrochemical Industry, Istanbul, Turkey, 22-26 June 1981 (ID/WG.336/3), tables I.11, I.13, I.15, I.17, I.18, I.20 and I.23.

a/ LDPE, HDPE, polypropylene, PVC and polystyrene.

b/ Acrylic, polyamide and polyester.

c/ SBR and polybutadiene.

d/ Industrialized and developing countries; figures for demand differ slighly from figures for production given in United Nations Industrial Development Organization, "Second world-wide study on the petrochemical industry: process of restructuring", Second Consultation on the Petrochemical Industry, Istanbul, Turkey, 22-26 June 1981 (ID/WG.336/3), p. 68, table I.32.

As in the case of steel, the growth of the petrochemical industry has been, over the last decade, fastest in third-world countries. As can be seen in table 8 for the case of ethylene, developing country growth rates for basic petrochemical demand were more than double the rates of growth in industrialized countries. This has meant that, despite rapid growth of petrochemical capacity in the third world, developing countries have provided a market for exports that is growing more rapidly than the domestic markets of industrialized countries. In the case of thermoplastic resins, for example, developing country imports are expected to more than double by 1984 over 1975 levels despite a fivefold increase in domestic capacity ([16], p. 70).

Also reminiscent of the case of steel is the extent to which the failure of the world economy to regain momentum in the early 1980s has created problems of over-capacity and falling demand in the industrialized countries during the last two years. In the case of synthetic fibres, for example, Western European firms reached an agreement in the fall of 1982 to cut back production by 17 per cent (550,000 tonnes) in order to compensate for dropping sales. This agreement replaced an earlier agreement, made in 1980, which decreased production by 440,000 tonnes (Wall Street Journal, 21 October 1982). While synthetic fibres are the least dynamic segment of the petrochemical industry, analogous problems have occurred in other branches of the industry.

Growth of the industry in the United States

The United States is the largest single market for chemicals in the world, with overall sales for chemicals reaching $150 billion in 1979 (Isaak [17], p. 5). Of this, petrochemicals account for over 40 per cent and industries dependent on petrochemicals (e.g., pharmaceuticals, paints, fertilizers) account for an almost equal amount ([18], p. 97). In recent years, however, the rate of growth of the domestic industry has begun to decline. United States plastic consumption grew at a rate of only 4 per cent per year between 1976 and 1980 and actually declined by 13 per cent between 1979 and 1980 ([19], pp. 4-5). Synthetic rubber consumption, hard hit by the problems of the auto industry, declined by 17 per cent between 1976 and 1980. As domestic demand has weakened, exports have become more important to the industry.

Although the United States petrochemical industry exports less than 20 per cent of its output, the proportion of exports has grown during the 1970s as the growth of exports has substantially exceeded the growth of the domestic industry. According to the United States Department of Commerce ([18], p. 99), "The value of United States petrochemical exports increased from $2.75 billion in 1973 to $11.80 billion in 1980 - a growth rate of 23.6 per cent per year". Imports are a fraction of exports and have generally amounted to less than 3 per cent of domestic consumption.

Exports to third world countries play an increasing role in the overall growth of exports. As table 9 indicates, while United States exports of plastics to Mexico and three markets in Asia doubled and quadrupled respectively between 1976 and 1980, the volume of exports to principal industrialized country markets increased by only 16 per cent. In the case of synthetic elastomers, United States exports to its principal developing country markets (Brazil, Mexico and Venezuela) also grew more rapidly than to its principal industrialized country markets, though the differences in this case were much smaller ([20], p. 21).

Table 9. Growth of United States exports of plastics and synthetic elastomers to third world markets

Market	Exports of synthetic resins and plastic materials 1976 Millions of kilograms	1976 Percentage	1980 Millions of kilograms	1980 Percentage	1976-1980 Percentage increase
Largest eight markets					
Mexico	106	8	248	10	134
Three other developing countries or areas combined a/	91	7	381	16	318
Four industrialized countries	460	35	532	22	16
Smaller markets (developing and industrialized countries)	664	50	1 264	52	90
Total	1 321	100	2 425	100	83

Source: United States International Trade Commission, Synthetic Elastomers, Supplement to Summary of Trade and Tariff Information, USITC Publication 841, Control No. 4-42 Supplement (Washington, D.C., 1981), p. 36, table 19.

a/ Hong Kong, Indonesia and China.

Promising though the growth of United States exports might appear, they are in fact disappointing in relation to the overall growth of world exports of petrochemicals. In the case of plastics, for example, United States shares of world export markets decreased from 27.3 per cent in 1962 to 16.8 per cent in 1970 and to 11.8 per cent in 1977 (Aho and Rosen [21], table 10). In terms of a "constant market share" analysis, United States actual exports of plastics were only 66 per cent of predicted exports in the 1962-1969 period and only 71 per cent of predicted exports in the 1970-1977 period. This performance raises questions as to whether United States competitiveness in petrochemicals is declining in the same way that United States competitiveness in steel has already declined.

The future of United States competitiveness

In contrast to United States steel companies, United States firms engaged in the production of petrochemicals have been technologically innovative, developing new products and improving productive processes. The recent development of linear low-density polyethylene is a good example. The contribution of United States engineering firms to the development of world-scale naptha crackers is another ([15], p. 261). In the

Table 10. Growth of developing country capacity in basic petrochemicals and thermoplastic resins, 1979-1987
(Thousands of metric tonnes a year)

Region or country	Olefins a/			Aromatics b/			Thermoplastic resins c/	
	1979	1984	1987	1979	1984	1987	1979	1984 d/
Latin America								
Brazil	1 320	2 100	2 110	430	620	620	1 026	1 601
Mexico	740	2 040	2 640	330	1 130	1 430	418	1 048
Argentina	290	390	910	295	295	355	143	502
Venezuela	240	240	590	--	--	150	137	251
Other	90	310	1 120	100	100	750	75	155
Total	2 680	5 090	7 370	1 155	2 145	3 305	1 799	3 557
Middle East e/	165	975	3 280	--	350	1 240	77	787
Asia f/	2 475	5 240	8 960	1 280	2 450	3 810	2 710	5 164
Africa g/	120	595	1 015	--	60	60	287	578
Total	5 440	11 900	20 625	2 435	5 005	8 415	4 873	10 085

Source: United Nations Industrial Development Organization, "Second world-wide study on the petrochemical industry: process of restructuring", Second Consultation on the Petrochemical Industry, Istanbul, Turkey, 22-26 June 1981 (ID/WG.336/3), pp. 41-45, tables 1.4-1.6B.

a/ Ethylene, propylene and butadiene.

b/ Para-xylene, ortho-xylene and benzene.

c/ Low-density polyethylene, high-density polyethylene, polypropylene, polyvinyl chloride and polystyrene.

d/ No reliable estimates for thermoplastic resins are available for 1987 for a large number of countries.

e/ Major producers include Iraq, the Islamic Republic of Iran, Kuwait, Qatar, Saudi Arabia and Turkey.

f/ Major producers include China, India, Indonesia, the Republic of Korea, and Singapore.

past, United States firms have also benefited from low-priced hydrocarbons. United States government price controls on oil and gas kept the cost of feedstocks and energy for United States producers well below those of the European and Japanese. Given that feedstocks and energy account for the majority of the total production costs of basic and intermediate petrochemicals, this advantage was considerable - so much so that the European Economic Community (EEC) lodged a formal complaint with the United States Government over the unfair cost advantage of United States producers ([18], p. 100). This competitive advantage is, however, in the process of disappearing:

> "Decontrol of petroleum prices has already eliminated an earlier cost advantage of the United States petrochemical industry. Projected deregulation of natural gas prices will lead to substantial increases in the prices of gas and of natural gas liquids and to higher petrochemical costs" ([18], p. 101).

As new entrants begin to come on stream in the oil-producing countries in the 1980s, the traditional United States cost advantage in feedstocks and energy will be eroded.

The role of new entrants in basic petrochemicals

Capacity in the industrialized countries will continue to grow, with the possible exception of Japan, which severely curtailed the growth of its petrochemical industry after 1973 and may even shrink some of its basic petrochemical capacity in the future. Growth in the industrialized countries however, will consist, at the maximum, of doubling capacity over the next decade ([15], p. 84). Capacity in the third world, on the other hand, will increase by at least five times, and probably five times, by 1990 (relative to 1979 levels).

The rise of developing country entrants

Prior to the late 1960s there was virtually no basic petrochemical capacity in developing countries. By the late 1970s several of the newly industrializing countries of Latin America and Asia had taken important initiatives to develop their own petrochemical industries. By the late 1980s developing country capacity will have quadrupled in olefins, more than tripled in aromatics and grown at a similar rate in downstream products. As table 10 shows, current developing country petrochemical capacity is not only concentrated, it also tends to be located not in oil-producing countries but in newly industrializing countries, whose primary interest lies in import substitution. Level of industrialization and ability to absorb technologically sophisticated projects rather than raw material availability seem to have been most important in determining the first wave of growth in developing country petrochemical capacity. In Latin America, for example, Brazil dominated the industry while Venezuela was only a marginal producer.

The projections shown in table 10 suggest that petrochemical development in the 1980s will follow a different logic. Growth will be more closely tied to the presence of hydrocarbon reserves, especially growth of capacity to produce the basic petrochemical building blocks (olefins and aromatics). Production of olefins in the Middle East will increase 20 times over in the space of eight years. Mexico rather than Brazil will come to dominate the production of olefins and aromatics in Latin America. These developments reflect the fact that feedstock and energy

costs have dramatically increased their share of total production costs, enabling oil-producing countries to become cost competitive even though their construction costs (the other most important element in the overall cost of producing petrochemicals) are much higher than those of more industrialized countries.

The shift in the location of third world petrochemical operations implies that future capacity is more likely to be export oriented. The plants being constructed in the Middle East are clearly designed for export to the industrialized countries (Isaak [17], pp. 50-51); [15], p. 72). New capacity in Latin America is less likely to be export oriented. But even in the case of Brazil, where most capacity was clearly built to satisfy domestic demand, certain projects have been proposed on the grounds that they will export their output and thereby help resolve balance-of-payments problems (see discussion of Dow Chemical Project, Evans [22]). In the case of Mexico, export is a much more likely possibility, especially if domestic demand is not growing as rapidly as expected and if oil exports prove inadequate to solve foreign exchange problems. This raises, of course, the question of the likely reaction to developing country exports on the part of the industrialized countries, a question whose answer is tied in part to the role of transnational corporations in the development of third world petrochemical capacity.

Involvement of transnational corporations in the expansion of developing countries' petrochemical capacity

Parallelling the shift of petrochemical capacity to countries with hydrocarbon reserves has been the determined downstream movement of the major oil companies into petrochemicals. Major oil companies now control between 40 and 60 per cent of the basic petrochemical capacity of EEC and have substantially extended their control over thermoplastic resins and certain intermediates. In the United States, major petroleum companies increased their control from 43 per cent of ethylene production in 1976 to 54 per cent in 1983 and also increased their control over thermoplastic resins ([15], pp. 295-297 and 305). Oil companies have now joined the traditional chemical companies as dominant actors in the control of existing petrochemical capacity. The same companies are doing their best to position themselves to take advantage of the growth of capacity in the developing countries.

Perhaps the most important initiative of United States transnational corporations has been in Saudi Arabia. United States transnational corporations are in a very good position in relation to the most likely source of developing countries' petrochemical exports to the industrialized countries. All the Saudi projects are 50/50 joint ventures with the Saudi Basic Industries Corporation (SABIC). In each case, one of the transnational corporation partners' major contribution is its counted-on ability to place the production in international markets (see Isaak [17], pp. 41-46).

Despite their heavy involvement in Latin America, United States transnational corporations have not predominated in the development of Latin American petrochemical complexes to the same degree that they have in Saudi Arabia. Domestic control over local productive capabilities and the "de-packaging" of technology have had an important place among the goals of Latin American countries trying to develop new petrochemical capacity. In Brazil and Mexico, sites of the most extensive petrochemical developments, the state-owned oil companies which control the evolution of the industry restricted the participation of transnational corporations

and bargained hard over the conditions of their entry. The terms laid down for participation have often made United States transnational corporations reluctant to enter, even in ventures for which participation by transnational corporations is solicited.

In Brazil's Camacari petrochemical complex, one of the largest fully integrated complexes in the world at the time of its construction, the State took control of the first generation (later sharing control with downstream companies) and the downstream companies were split on a "tripod" formula - one third State ownership, one third local capital and one third transnational corporations (see Evans [23]). Careful attention was paid to the issue of acquiring access to the technology involved in the operation of the plants being set up. Few United States transnational corporations opted to become involved, while Japanese transnational corporations used the opportunity to acquire a place in the Brazilian market. In the most recent Brazilian complex, even more emphasis was placed on the "de-packaging" of technology (Sercovich [24]). The contract to construct the naptha cracker was obtained on the basis of an agreement that not only provided technicians full access to the design process but also envisaged the possibility of Brazil one day being able to construct naptha crackers in third countries (Evans [22]).

A look at the new Mexican petrochemical complexes also makes the differences between the Latin American and Middle Eastern situations clear. They are wholly owned by Petroleos Mexicanos (PEMEX). Among the engineering and contracting firms involved in their construction, one does not find the familiar United States firms that are so central to the Saudi projects. Instead one finds the contracting controlled by PEMEX itself and the engineering done by local firms ([25], pp. 19-20 and 37-38).

United States transnational corporations are centrally involved in the development of the petrochemical industry in developing countries, including its development in Latin America. But, in the major complexes producing basic petrochemicals and major thermoplastic resins, the United States transnational corporations are much more thoroughly wedded to the developments in the Arabian peninsula than they are to developments in Latin America. Whether this will make a difference in terms of the evolution of United States policy remains to be seen, but it is a fact which cannot be ignored.

Technological change and product specialization

The era of major technological breakthroughs in basic petrochemicals is probably drawing to a close. The technology necessary to produce the basic petrochemical building blocks is no longer under the exclusive proprietary control of producing companies, but may be obtained from a variety of engineering firms world-wide. Consequently, basic petrochemicals as well as the major thermoplastic resins, synthetic fibres and synthetic elastomers have taken on the character of commodities, products in which monopoly power is harder to obtain and requires, to an increasing degree, control over marketing and distribution as well as production if it is to be obtained at all. The major oil companies can still hope to exercise some degree of monopoly power based on their control over feedstocks and energy sources, but chemical companies, even the chemical subsidiaries of the major oil companies, are tending toward an increasing focus downstream where exclusive proprietary positions can be secured in specialized products and the possibility of strong monopoly position is easier to

envisage. Rather than specializing in fertilizers, for example, transnational corporations are beginning to focus more of their efforts on agricultural chemicals.

The implications of this evolution for the international division of labour are not entirely clear. A "product cycle" model of the international division of labour might well develop in petrochemicals. Developing countries with hydrocarbon reserves would export those basic commodity petrochemicals for which production technologies are widely diffused while industrial countries focused on the export of fine chemicals. Such a model depends, of course, on a relatively high rate of product innovation in the industry. It also leaves undefined the position of countries like Brazil and Mexico which can realistically aspire to local production of more sophisticated chemical products. It also depends on the industrial policies of the industrialized countries.

The sources and shape of future United States industrial policy

The forces shaping United States industrial policy in petrochemicals are quite different from those affecting policy in steel. Petrochemical plants are the epitomy of capital-intensive process technology and the position of labour in the industry is very different than in steel. As has already been pointed out, the firms involved are also very different. They are, first of all, intensely multinational. They are also, as Franko [9] points out, highly diversified and therefore less likely to see protection of markets for particular products as critical to their survival. Franko's analysis of actions to restrict imports in the EEC bears out the differences. Of 175 actions taken from 1974 to 1978, 75 involved the steel industry and only 9 involved chemicals and fertilizers (Franko [9], p. 494). In the United States, even more clearly than in the EEC, there is a strong contrast between steel and petrochemicals as far as the issue of protectionism is concerned, both on the part of capital and on the part of labour.

The position of labour in petrochemicals

Wages and salaries in petrochemical production generally account for no more than 10 per cent, and sometimes as little as 2 per cent of the total production costs ([15], p. 90). The implications of this evolution for the international division of labour are not entirely clear. A "product cycle" model of the international division of labour might well develop in petrochemicals. According to the United States Department of Commerce ([18], p. 97), production workers in the industry in the United States in 1978 produced $6.77 of value added for every dollar they received in wages (as compared to $3.90 for United States manufacturing overall and $2.60 for steel workers - see table 5). Given the heavy weight of fixed costs in the industry, and the critical importance of avoiding "downtime", it is the degree to which workers effectively fulfil monitoring and maintenance responsibilities rather than wage rates that are critical to profitability. Because the industry is so capital-intensive, the absolute number of workers involved is relatively small. In 1978 the value of shipments for the steel and petrochemical industries was about the same, but there were over 400,000 workers involved in steel production and only 200,000 involved in petrochemicals. Finally, the regional distribution of the industry within the United States is very different. Instead of being located primarily in the north-central and north-eastern parts of the country, hard hit by the recession of a variety

of traditional industries, petrochemical plants are more likely to be found on the Gulf Coast, where the regional economy overall has benefited rather than suffered from rising energy prices.

This is not to say that workers in the petrochemical industry are immune from the general downturn in demand for industrial products. Employment in the plastics industry declined by 10 per cent between 1976 and 1980 ([19], p. 1). Even if this distress were to get worse, however, low ratios of imports to domestic consumption and the high ratios of exports to imports in these industries make it unlikely that it would be translated into demands for insulation from international markets.

The policy preferences of United States firms

Since firms involved in the petrochemical industry are diverse and characterized by complex corporate strategies, prediction of their policy preferences is of necessity a speculative venture. However, some of the considerations that are likely to go into shaping firm preferences can be outlined and their possible implications discussed.

First of all, the degree of oligopolistic control which prevades even the markets for commodity petrochemicals must be recognized. Concentration is lower in the United States than in EEC (where from four to eight firms control 100 per cent of ethylene supplies in France, Italy, the Netherlands, and the United Kingdom). But even in the United States the top eight firms control 66 per cent of supplies of ethylene. Further downstream, control, based on exclusive product or process technology, may be even tighter, depending on the individual product. Given the high proportion of fixed costs in the industry and the consequently high penalties for operating at low levels of capacity, firms must place a premium on avoiding "cut-throat" competition, particularly in commodity petrochemicals where product differentiation is difficult. The firms' strategies are not difficult to understand; what is more complex is trying to decipher their implications for firm attitudes toward industrial policy in general and more specifically toward policies which might affect the fortunes of developing country producers.

On the one hand, transnational corporations try to avoid the dispersion of technology and production capacity to producers who might act as "spoilers" in the market. On the other hand, given the difficulty of preventing the dispersion of technology and productive capacity in the commodity petrochemicals where non-producers (engineering and consulting firms) already command the necessary technologies and are anxious to get a return on their knowledge by constructing new plants, participation in the development of new third-world productive capacity would seem to be the best way of preserving "order" in the market, particularly if the new capacity is in locations that would seem to have a long-run cost advantage. This would seem to be the strategy in the Saudi Arabian case.

The major question arises in the case of possible exports back into the United States, especially if the eventual results of such exports might be to force firms to write off some of their older, less efficient United States capacity. This becomes even more sensitive in cases, like Mexico, in which the foreign capacity involved is not controlled (even jointly) by the United States transnational corporations. If United States transnational corporations were to decide that increased access to the United States market by foreign-controlled industries was detrimental to their long-term interests, United States industrial policy in petrochemicals could move in the same negative directions as the United States industrial policy in steel.

Current and future United States policy

The most important "industrial policy" to date as far as the petrochemicals industry is concerned has probably been the control of oil and gas prices. Abandonment of these controls makes the United States industry more vulnerable to international competition. If demand for major intermediates and final products continues to stagnate, pressure for tariff protection might increase. Entry of basic petrochemicals is now free ([15], p. 186), but since transport of the highest volume basics (ethylene and propylene) requires expensive cryogenic facilities, the tariffs on intermediates are really more crucial. The effective rate of protection on major thermoplastic resins varied in 1980 between 19 and 28 per cent ([15], p. 190), already a substantial barrier for potential third world exporters to face. There is, then, a foundation on which an industrial policy oriented toward retarding changes in the international division of labour could be built. Whether such a policy will be attempted remains to be seen, but a policy aimed at cutting off the possibility of exports to the United States market would be a severe blow to the long-run development of third world petrochemical industries.

A related issue on which United States policy could impede the development of the Latin American industry is the question of "counter-trade" or "buy-back" agreements. Such agreements have already been important in the development of the petrochemical industry in Eastern Europe and might be useful to the development of the Latin American industry in the future if the problems with international financing, which currently prevail in the region, persist. The United States currently considers such arrangements as tending toward discriminatory practices and therefore as possibly contrary to the General Agreement on Tariffs and Trade [26]. A hardening of this position could make a potentially useful strategy more difficult for Latin Americans to employ, although it would probably still be possible to work out such arrangements with other industrialized countries.

A final area in which United States policy might affect the development of the Latin American industry is technology. Increased government support for research and development in the industry might actually work to the advantage of Latin American producers since it would ideally have the effect of speeding up the product cycle and lessening the dependence of United States producers on standard products in which Latin American industries are likely to compete. On the other hand, heightened United States opposition to Latin American attempts to limit entry to firms which are willing to share equity and technology could be a problem for Latin American industrial plans, especially if the United States attempted to make relaxation of these restrictions a condition for access to international financing or linked the issue to trade and tariff questions.

Implications for petrochemical industries in Latin America

The country whose future petrochemical industry is most likely to be affected by United States industrial policy is Mexico. Mexico is not only likely to dominate the region in this industry (see table 10), it is also the country with the greatest prospect of exporting petrochemicals to the United States market, both because of its locational advantages as far as transportation costs are concerned and because of the prospective cost structure of its production.

According to calculations by the United Nations Industrial Development Organization (UNIDO), Mexico suffers a 25 per cent "locational" disadvantage as far as capital costs are concerned ([15], p. 104); that is, costs per tonne of output of installing new capacity in Mexico are calculated to be about 25 per cent higher than the costs of installing similar capacity on the United States Gulf Coast. In compensation, feedstock costs for Mexican producers may be as little as 25 per cent of the feedstock costs faced by United States producers (as in the case of making ethylene from ethane) ([15], p. 14). Consequently, for a number of basic and intermediate products, Mexican production costs are lower than United States production costs. In the case of methanol, for example, Mexican production costs are about half of United States production costs ([15], p. 142). In the future, these differences are likely to widen as United States feedstock costs are pushed up by the decontrol of natural gas prices and Mexico's relative disadvantage in terms of capital costs diminishes. Mexico's locational disadvantage in construction costs is projected to be only about 18 per cent by 1985.

The implications of these cost differentials are explored for the case of thermoplastic resins in tables 11 and 12. As is clear from table 11, Mexican production costs are already below both United States production costs and United States market prices for most thermoplastic resins. If PEMEX were willing to forego a 25 per cent return on investment (ROI) in order to increase foreign exchange earnings, Mexican thermoplastics could become even more cost competitive. Mexican production is likely to become even more competitive by 1985.

Looking at table 12, it is equally clear why Mexican thermoplastics will constitute no competitive threat to the United States domestic market during the first half of the 1980s. Mexican capacity is small even in relation to current imports from the United States. Barring a catastrophic drop in demand within Mexico itself, new capacity will be fully engaged in trying to fill domestic demand. United States producers may face the loss of an export market, but this is so small in relation to the United States domestic market that variations in the rate of growth of the domestic market will be much more important in determining the fortunes of United States domestic producers.

Table 12 also makes clear the tremendous potential importance of United States policies with regard to the longer-term future of Mexican producers. If Mexican producers were allowed access to the United States domestic market, their potential for expansion, quite independently of the growth of the Mexican market, would be virtually unlimited. Since Mexican capital costs are about one sixth less than those of plants constructed in the Middle East and since Mexico would have the advantage of lower transportation costs, it could even compete with potential exports from the Middle East (see [15], pp. 104 and 153). Exports of basic and intermediate petrochemicals could provide Mexico with a way of increasing the local value added derived from its hydrocarbon reserves while at the same time enhancing the technological level of its manufacturing sector. The development of an export-oriented petrochemical sector would be even more attractive if it could be financed on the basis of counter-trade or buy-back agreements.

Table 11. Mexican competitiveness in major thermoplastic resins, 1980
(Dollars a tonne)

Substance	United States		Mexico
	Production costs	Market price	Production costs
High-density polyethylene	1 061	918	988
Low-density polyethylene	979	1 030	958
Polypropylene	876	1 040	733
Polystyrene	1 086	1 010	911
Polyvinyl chloride	1 090	761	1 497

Source: United Nations Industrial Development Organization, "Second world-wide study on the petrochemical industry: process of restructuring", Second Consultation on the Petrochemical Industry, Istanbul, Turkey, 22-26 June 1981 (ID/WG.336/3), p. 142.

Note: Based on 25 per cent return on investment and 85 per cent load factor.

Table 12. Mexican capacity and the United States thermoplastics market
(Thousands of tonnes)

Substance	United States consumption in 1980	United States imports in 1980	United States exports to Mexico in 1980	Mexican capacity in 1984
High-density polyethylene	4 097	104	97	200
Low-density polyethylene	5 591	24	220	340
Polypropylene	2 537	3	163	100
Polystyrene	4 995	7	–	148
Polyvinyl chloride	4 072	57	–	260

Source: United States International Trade Commission, Synthetic Elastomers, Supplement to Summary of Trade and Tariff Information, USITC Publication 841, Control No. 4-42 supplement (Washington, D.C., 1981), various tables; for Mexican capacity, United Nations Industrial Development Organization, "Second world-wide study on the petrochemical industry: process of restructuring", Second Consultation on the Petrochemical Industry, Istanbul, Turkey, 22-26 June 1981 (ID/WG.336), p. 142.

The likelihood of this scenario depends to a great extent on a United States industrial policy aimed at shifting United States production away from commodity petrochemicals toward more technologically advanced downstream products. If, instead, United States policy in the late 1980s and

1990s were to be oriented toward trying to preserve the return on aging domestic naptha crackers by insulating their output from international competition, or if it were to be aimed at providing special access to the United States market for third world production in which United States transnational corporations played a more dominant role, an important option for industrial development in Mexico will have been lost.

Electronics: geographical differentiation within firms and between products

The electronics industry has grown so rapidly in the last two decades that some have claimed that it has "served as the basis of a second industrial revolution" (Volk [8], p. 110). During the course of this growth, segments of the industry have evolved in very different ways, both within the United States and globally. The discussion that follows looks at the disparate evolution of three segments of the industry: consumer electronics, semi-conductors, and computers. Table 13 provides some idea of their evolution over the last 10 years.

Technological change and the expansion of United States electronics firms

United States firms pioneered each of the three segments of the electronics industry and at one time had commanding technological leads in each of them. By the end of the 1970s, their situations had diverged. In consumer electronics, many United States firms had been driven out of business. Those that remained were at a competitive disadvantage in a number of important product lines. In semi-conductors, United States firms remained competitive, in part because they had dispersed parts of their production operations to other countries, but the future was uncertain. Only in computers did the United States retain its commanding lead.

Consumer electronics - the decline of the United States industry

As table 13 indicates, the United States position in television receivers, traditionally the most important product line within the consumer electronics sector, has been steadily eroded over the course of the 1970s. Local production of black-and-white television sets has been essentially abdicated. Domestic production of colour television sets appeared to be heading in the same direction until an orderly marketing agreement (OMA) was negotiated with Japan in 1977 and later followed up by agreements with Taiwan Province of China and the Republic of Korea. As table 14 indicates, the ratio of value added to production-worker wages is substantially lower in the consumer electronics sector than in semi-conductors or computers. More important from the point of view of labour, changes in the production process spurred by international competitive pressure have resulted in massive declines in the number of people employed in this segment of the industry. Employment in consumer electronics overall declined by over 40 per cent between 1966 and 1978, and employment in television receivers declined over 50 per cent (Gray, Pupel and Walter [27], p. 156).

Of 27 United States firms producing television receivers in 1960, only five were still doing so in 1980 (Magaziner and Reich [28], p. 171). Diversified electronics firms, able to benefit from substantial cross-product economies of scale in advertising, had managed to stay in the business. They were operating behind the protection of OMAs and utilizing

Table 13. United States production and trade in electronics, 1968-1979

Year	Television receivers			Semi-conductors			Computers	
	Domestic production a/ (millions of sets)	Imports as a percentage of total sales		Domestic shipments (billions of dollars)	Exports as a percentage of domestic production	Imports as a percentage of domestic production	Domestic production (billions of dollars)	Exports as a percentage of domestic production
		Black and white	Colour					
1968 (1970) b/	8.9	37	11	1.4	14	6	5.7	22
1975	7.3	60	19	3.0	35	29	8.4	26
1977	7.4	87	28	4.4	34	32	13.4	24
1978	7.6	98	27	5.3	29	31	-	-
1979	8.9	94	14	6.9	30	32	20.9	25

Source: United States, Congress, Office of Technology Assessment, United States Industrial Competitiveness: A Comparison of Steel, Electronics and Automobiles, OTA-ISC-135 (Washington, D.C., Government Printing Office, 1981), p. 52.

a/ Domestic production estimated by total sales minus imports.

b/ Data for television receivers and semi-conductors is from 1968; data for computers is from 1970.

an extensive amount of offshore assembly to lower labour costs. Even so, their production costs were still reputed to be higher than those of low-cost Japanese producers, whether Japanese production was done in the United States or in Japan.

Even more disturbing from the point of view of the United States manufacturing sector is the high import penetration in other consumer electronic product lines where domestic demand is growing more rapidly than it is for television receivers. In 1978, imports accounted for 100 per cent of the market for videotape players and recorders as of 1978. For electronic watches and high fidelity and stereo components, the figures were 68 per cent and 64 per cent respectively ([29], p. 77). While United States firms have a strong position in certain new consumer electronics products (e.g. video games and video disk recorders), it is clearly open to doubt whether consumer electronics will survive as an important subsector of the United States domestic industry.

Semi-conductors - rapid innovation and profitability problems

The semi-conductor industry grew out of the United States invention and commercialization of the transistor and is currently dominated by ever more complex integrated circuits. In certain respects the semi-conductors have behaved very much like a classically competitive industry. Competition has been intense, quality has improved, and prices have fallen. Since value-added figures do not take into account falling prices for improved products, the figures in table 14 substantially understate the real increase in output per production-worker hour. According to one estimate, the cost per bit of information capacity in the semi-conductor industry has declined 35 per cent each year since 1970 ([30], p. 150; see [29], p. 136). The current structure of the industry, however, hardly conforms to neo-classical models of "atomistic competition". Firms are large and multinational and the relations between producers and major customers are tight and sometimes reinforced by equity links.

United States producers continue to hold a dominant position in the industry. Estimates of world semi-conductor production by geographical location of firm headquarters (as opposed to the location of the production itself) suggest that the control of semi-conductor production by United States firms has increased from 53 per cent in 1978 to 64 per cent in 1981 ([29], p. 136). The location of the production itself is, of course, another matter. As table 13 indicates, one of the major shifts in the industry in the late 1960s was that it became rapidly internationalized with exports rising from 14 per cent of domestic production in 1968 to 35 per cent in 1975 and imports rising even more rapidly, from 6 to 29 per cent. The crucial characteristic of the trade patterns in the industry, and the one that distinguishes it most clearly from consumer electronics, is that internationalization has not meant simply import penetration, but rather a joint rise in imports and exports.

The United States semi-conductor industry does not seem to be going the way of the consumer electronics industry, but the situation of United States firms has become increasingly difficult in recent years. On the one hand, the industry has become increasingly capital intensive. Capital investments have risen from 12 per cent of sales in 1970 to 21 per cent in 1981 ([30], p. 53). The costs of the capital equipment necessary to set up a wafer fabrication facility increased from $500 thousand in 1967 to $10 million in 1979 and are projected to rise between three and a half and five times by 1985 ([30], p. 106). At the same time, Japanese companies

Table 14. Wages and value-added in the electronics industry
(Dollars)

Year	Television receivers			Semi-conductors			Computers			Ratios
	Value added per hour (1)	Hourly wage (2)	Ratio of (1) to (2)	Value added per hour (1)	Hourly wage (2)	Ratio of (1) to (2)	Value added per hour (1)	Hourly wage (2)	Ratio of (1) to (2)	All manufacturing b/
1960	6.40	2.06	3.1	8.64	1.86	4.6	–	2.60	–	3.0
1970	10.64	3.00	3.5	16.11	3.07	5.2	21.18	3.75	5.6	3.4
1977	22.81	4.93	4.6	27.40	5.02	5.5	45.20	5.41	8.4	3.9

Source: United States, Congress, Office of Technology Assessment, United States Industrial competitiveness: A comparison of Steel, Electronics and Automobiles, OTA-ISC-135 (Washington, D.C., Government Printing Office, 1981), pp. 55-59.

a/ Wages and value added are per production-worker hour.

b/ See table 5 for wages and value added per production-worker hour for all manufacturing.

have closed the technological gap between themselves and United States producers and increased their share of the market on the basis of strong price competition combined with high quality standards. The result has been falling profit margins within the industry and increasing difficulty in financing capital expansion and research and development.

In the last two years these difficulties have been magnified by problems of demand. In response to the 1974-1975 recession, United States producers cut production, employment and investment. The Japanese used the inability of United States producers to fully supply the market after the recession to expand their own market share. As demand fell again in the second half of 1980, United States producers were more cautious, but when the predicted recovery in market growth still had not arrived in 1981 (or 1982) a "ferocious" price war ensued. The price of 16K random access memories (RAMs), for example, fell from $5.50 to $1.00 between January and June of 1981 ([30], p. 60).

The longer-term prospects for the semi-conductor market are excellent. As new end uses for semi-conductors, both in productive and consumer goods, multiply, demand will expand and in the event of an even moderate overall recovery in world-wide growth rates, growth rates in semi-conductors should return to the kind of levels that led to a more than doubling of the dollar value of United States domestic shipments between 1975 and 1979. As far as the technological position of United States firms is concerned, the assessment of UNIDO is that

> "... it would seem as if circuit innovation would be decisive for the next rounds of the competition. In this area, the United States companies still seem to be the undisputed leaders." ([30], p. 62)

In short, the 1980s are likely to be an uncertain and challenging time for the United States semi-conductor industry, and preservation of their currently dominant global position is by no means assured, but there is no evidence at present that the industry is likely to follow the path of steel or consumer electronics.

Computers - future of United States dominance

The United States continues to dominate the computer industry world-wide. As the Office of Technology Assessment puts it ([29], p. 89), "If there is an industry in which the United States is internationally competitive par excellence it would have to be computers". About two thirds of the computers in Europe are the product of United States-owned firms. The 45 per cent share of United States computer firms in the Japanese market is even more impressive. At the same time, "virtually none of the computers in the United States have been designed and built by foreign firms" ([29], p. 52). As might be expected, United States dominance is as great in most Latin American markets as it is in Europe. In Mexico and Venezuela, for example, the United States supplies about 70 per cent of computer imports, with the rest being dispersed widely among Japan, France, the Federal Republic of Germany and the United Kingdom ([31], p. 9, [32], p. 7).

The tremendous resources at the disposal of United States computer companies will make it very difficult for European countries to close the gap which currently separates them from United States manufacturers. The major United States companies spent more than $1.5 billion on research and development in 1980 (Business Week, 6 July 1981, p. 66) and $2.25 billion

to automate its production facilities (Business Week, 23 March 1981). If there is indeed a "capital crunch" coming in computers ([30], p. 196), the United States computer industry is in a good position to meet it.

The future dominance of United States firms cannot, however, be taken for granted, as the recent National Science Foundation Report on Large-Scale Computing [33] makes clear. The Japanese Ministry of International Trade and Industry (MITI) has embarked on an ambitious programme aimed at the development of very high speed, large memory "super-computers", which involves six major Japanese computer producers and will be funded at a level of about $200 million. Simultaneously, MITI is sponsoring a project designed to explore ways of reorienting the way in which computers manipulate data, known as the "Fifth Generation Computer Project". Finally, individual Japanese companies have also embarked on projects which could represent serious challenges to current United States dominance; for example, the "Vector Processor", which is designed to "exceed the performance of the Cray-1 up to a factor of 5" ([33], p. AIII-3).

In the absence of a United States industrial policy aimed at promoting a similar level of basic innovation in the United States computer industry, future Japanese dominance must be considered at least a possibility. The members of the National Science Foundation panel on Large-Scale Computing in Science and Engineering concluded their findings by saying, "The panel believes that current funding levels are insufficient to maintain the Nation's leadership in large-scale computing" ([33], Executive Summary). Thus, even in the computer industry the international position of United States manufacturing will depend at least in part on United States industrial policy.

The changing geographical distribution of productive activities

The electronics industry as a whole epitomizes the capacity of transnational corporations to break down the production process into distinct phases requiring varying amounts of technology, capital and labour and then to disperse more labour-intensive aspects of the process to third world locations while keeping the more capitaland knowledge-intensive parts close to the corporate headquarters. If the electronics industry shows nothing else, it shows that there is no necessary relationship between the degree of capital and/or knowledge intensity that characterizes an industry globally and the possibilities for labour-intensive, export-oriented assembly operations in third world countries. It also helps underline the fact that opportunities for intra-corporate exports from developing countries back to the United States are most likely to be found in industries where United States transnational corporations have the highest degree of control over the international organization of the productive process. The geographical strategies of transnational corporations have provided opportunities for developing countries interested in export-oriented manufacturing development. But the long-run returns to collaboration in these strategies are far from clear. In part, they are unclear because the extent to which future transnational corporation strategies will continue to replicate the current geographical division of labour is unclear.

Consumer electronics - problems of locating production in lower-wage areas

In their analysis of the current evolution of the consumer electronics industry, Gray and his collaborators ([27], p. 159) summarize the strategy of United States transnational corporations as follows:

> "Japanese consumer electronics manufacturers focused on product development and high volume production, linked to a sophisticated strategy for gaining a substantial part of United States markets. Their American competitors eschewed this approach, responding primarily by relocating much of their operations in lower-cost production sites."

The results of this strategy showed up in the tremendous increase of imports of 806.3/807 television receivers and parts back to the United States from the overseas subsidiaries or sub-contractors of United States transnational corporations. Imports of television receivers under 806.3/807 increased more than 10-fold between 1966 and 1975 as did imports of components and parts (Gray, Pugel and Walter [27], p. 157). Yet the use of low-cost (mainly East Asian) labour was insufficient to stem the tide of Japanese imports and, subsequently, imports from other East Asian countries.

The difficulties of United States television manufacturers have been well outlined by Magaziner and Reich ([28], p. 173). Analysing the comparative costs of United States and Japanese producers, they discovered that by locating production facilities accounting for just over half the labour inputs abroad, United States firms had in fact reduced their total average wage rate to 50-60 per cent of the Japanese rate, but Japanese process innovations had reduced the labour input per set to 30-50 per cent of the time required by the United States production processes. Consequently, Japanese direct labour costs remained low despite the higher Japanese wage rates.

While the OMAs negotiated beginning in 1977 have taken the pressure off United States producers of colour televisions, they have not changed comparative manufacturing costs. Since the Japanese competitive advantage was not based on low wage rates, there was no barrier to them setting up production in the United States and becoming part of the "domestic" industry. Between 1978 and 1980 the United States output of Japanese manufacturers more than doubled, which meant that local production in the United States had acquired a market share in the same range as that held by the Japanese imports prior to the imposition of the OMA (Magaziner and Reich [28], p. 170). As Japanese production in the United States increased, imports from Japan diminished sufficiently so that the OMA with Japan could be allowed to expire (though the OMAs with Taiwan Province of China and the Republic of Korea remained in effect until mid-1982) ([29], p. 115).

It would be an exaggeration to suggest that as transnational corporations in consumer electronics more fully explore the trade-offs between innovation and low wage rates, they are likely to end up "relocating in the North" ([30], pp. 210-215). Analysis of changing assembly technology and geographical location suggests that Japanese companies may simultaneously use automated assembly techniques at home and more labour-intensive ones abroad and that United States firms are also making simultaneous use of more and less labour-intensive production technologies in different locations ([30], pp. 212-215). Even within advanced industrial countries, a variety of different production technologies may be introduced at certain favoured locations within the third world.

All of this suggests that the future geographical distribution of assembly operations will follow neither a simple "cheap labour" logic nor a straightforward "automate and centralize" logic, but will be shaped by a

complicated interaction of the two. Nonetheless, a country like Mexico, which has become the dominant assembler of television parts and apparatus for United States producers (see table 17 below), must take into account the extent to which its position is vulnerable to changes in technology.

The geographical division of labour in semi-conductors

Shifting patterns of production location in semi-conductors mirror the patterns in consumer electronics, but the more clear-cut technological differentiation of the production process makes the geographical division of labour more likely to remain stable. Nonetheless, in semi-conductors, as in consumer electronics, the flow of United States firms to third world locations may be in the process of slowing down.

The process of chip (integrated circuit) fabrication can be roughly divided into four stages: design, wafer fabrication, assembly/bonding, and testing. Traditionally, only the third stage has been relocated to low labour-cost areas. Design is, of course, highly knowledge-intensive. Wafer fabrication is extremely capital-intensive. The difficulties of trying to relocate the capital-intensive phases of the industry abroad are greatly intensified by the rapid rate of innovation in the industry. The average age of capital equipment in the industry is only 4.4 years ([30], p. 53), and continues to fall. A wafer fabricator must continually introduce new production equipment and replace old equipment. Proximity to suppliers and sophisticated maintenance facilities is consequently very important. Until the process of technological change in wafer fabrication slows down, it will be difficult for third world countries to acquire more than assembly operations (though Singapore is trying to move in that direction) ([30], p. 227).

Despite the difficulties of moving other phases of the production process abroad, overseas assembly remains critical to the industry. Assembly operations are labour-intensive, so much so that overseas employment in the industry is reputed to amount to 80 per cent of United States domestic employment ([34], p. 8). Survey data collected by the United States International Trade Commission in 1979 indicate that the overseas employment as a proportion of total employment in United States semiconductor firms increased significantly during and after the 1974-1975 recession. Between 1969 and 1978 the proportion of United States semiconductors assembled offshore increased from 40 per cent to between 78 and 93 per cent (Flamm [35], pp. 377 and 445).

Given the rate of technological change in the industry, investing in capital-intensive equipment to automate production could easily backfire as new product technologies make the equipment obsolete. The semiconductors used in computers have a life span of about 24 months. If production equipment must be changed along with the product, the capital investment required for automated assembly is likely to be prohibitive. Thus, while there have been calls in semi-conductors, as in consumer electronics, to automate assembly operations and bring them back onshore ([30], p. 254), there does not seem to have been any significant movement in this direction. In 1981, 78 per cent of the semi-conductors imported into the United States came under 806.3/807, which is to say they represented re-imports of United States wafers that had been assembled abroad.

The apparent robustness of the offshore assembly strategy in semiconductors should not be exaggerated. First of all, as chips become larger and more complex, the proportion of the total cost accounted for by

assembly labour decreases dramatically. For a discrete semi-conductor of a simple integrated circuit assembly, labour may account for a third of the total cost. For a complex chip, it may account for less than 5 per cent (Flamm [35], p. 410c). Thus, the relative importance of assembly wages diminishes as chips become larger. At the same time the importance of quality control increases with the scale of the chip and, since automated assembly makes defect detection easier (Flamm [35], p. 338), this may make manual (and by implication offshore) assembly less attractive as chips grow larger and denser. For Latin America in general, and especially for countries like Mexico, which is a major supplier of semi-conductors to the United States, the evolution of the geographical division of labour in semi-conductors must be an important issue. To some degree, this future will be affected by United States industrial policy, but the more immediate determinants are likely to be firm strategies and the technological evolution of the industry.

Participating in the geographical division of labour as United States firms have defined it in the semi-conductor industry does tie third world producers into a rapidly growing market. Imports of semi-conductors under 806.3/807 grew 10-fold between 1970 and 1978 and had almost doubled again by 1980, despite the downturn in the United States market for semi-conductors during 1980. On the other hand, the participation of developing countries is limited, it appears, to a shrinking segment of the value added. As integrated circuits become denser and more complex, the exported chip contains a larger and larger share. The evolution of the share of offshore assemblers in the value added of 806.3/807 imports of semi-conductors gives an indication of the trend. After a peak of about 55 per cent of value added in the early 1970s, the offshore share has fallen steadily, reaching a low of 33 per cent in 1981 (see table 15).

There is even some indication that the more promising role for at least the largest Latin American countries may lie not in participating in the geographical division of labour in the production of semi-conductors but in working in the direction of import substitution. While exports of semi-conductors from Mexico to the United States came close to doubling between 1977 and 1981, exports from the United States to Mexico increased by more than two and a half times ([34], pp. 28-29). The recent increase in corporate plans for semi-conductors facilities in Brazil aimed at "access to the potentially huge Latin American market" rather than export back to the United States ([30], p. 241), is also an indication that semi-conductors may have reached a point at which import substitution - rather than filling a "cheap labour" slot in the division of labour - may be the most promising avenue for the development of the industry in Latin America.

Computers - continued geographical centralization

Since the computer industry is a major consumer of semi-conductors, accounting for about 35 per cent of United States consumption ([34], p. 11), the industry participates indirectly in the geographical division of labour as defined by the semi-conductor industry. Beyond this indirect participation, however, the computer industry is concentrated in the industrialized countries. While major computing firms have set up subsidiaries in Latin America, these are primarily sales organizations. One major company does assemble computers for export in Brazil [36], but, in general, integrated "IBM" computer manufacturing operations have not been set up.

Table 15. United States 806.3/807 imports of semi-conductors, 1970-1981
(Millions of dollars)

	(1) Total United States imports	(2) 806.3/807 imports	(3) Foreign value added a/	(3) as a percentage of (2)	(3) as a percentage of (1)
1970	157	139	61	44	39
1973	619	410	225	55	36
1977	1 358	864	407	47	30
1978	1 790	1 329	536	40	30
1979	2 448	1 852	711	38	29
1980	3 348	2 451	909	37	27
1981	3 582	2 805	918	33	26

Sources: For 1970 and 1973, United Nations Industrial Development Organization, "Restructuring world industry in a period of crisis - the role of innovation: an analysis of recent developments in the semi-conductor industry" (UNIDO/IS.285), p. 246; for 1978-1979 and 1980, United States International Trade Commission, Imports Under Items 806.30 and 807.00 of the Tariff Schedules of the United States 1977-1980, USITC Publication 1170 (Washington, D.C., 1981), pp. 40-41; and for 1977 and 1981, United States International Trade Commission, Semiconductors, Summary of Trade and Tariff Information, USITC Publication 841, Control No. 6-5-22 (Washington, D.C., 1982), p. 15.

a/ Foreign value added = dutiable value = total 806.3/807 minus United States content.

Latin American markets are increasingly important to the computer industry. In the late 1970s, Brazil and Mexico ranked among the more rapidly growing markets for computers in the world ([5], p. 231). The market for computers and peripheral equipment in other Latin American countries is also expected to grow rapidly (see, for example, [32], p. 2, on market projects for Venezuela). Despite this increasingly attractive market, however, United States transnational corporations in the computer field have been very wary of setting up any Latin American facilities that might dilute control of the technology which is their primary source of high returns. The relative lack of success of the Brazilians in their attempts at breaking through the monopoly of the industrialized countries in the production of computers (discussed below) is indicative of the difficulties that will confront any Latin American attempts to change the geographical division of labour in this industry.

Possibilities for future United States industrial policy in the electronics industry

Since electronics is the archetypal "sunrise" industry, it would be an obvious candidate for positive adjustment policies were United States industrial policy to move in the direction of positive adjustment. So far, however, government stimulation of the industry has come primarily through the effects of defence procurement. Nor is there any immediate prospect for other kinds of stimulation in the future. On the other hand, there is also little prospect that attempts to insulate the industry from international competition or to retard the process of structural change within the industry will go beyond the limited attempts that have already been made in consumer electronics.

Limits on the potential for protectionist policies

Gray and his collaborators ([27], p. 158) summarize the main thrust of United States government policy towards the electronics industry as having "meant that it has been easier for major firms to adapt to competitive challenges by relocating facilities abroad". The network of international investment that has emerged, partially in response to this policy, makes it exceedingly unlikely that substantial protectionist barriers will be erected in the electronics industry. Even in consumer electronics, United States producers rely too heavily on imported parts and sub-assemblies to advocate serious moves in the direction of greater protectionism. In addition, the initiation of local United States assembly operations by Japanese firms has demonstrated that barriers to trade will not provide protection from international competition.

In semi-conductors and computers the prospects for any kind of trade restriction seem even smaller. The computer industry does not need protection. In addition, it benefits substantially from international competition in the chip market. Even though the major computer corporation in the United States is one of the largest domestic semi-conductor manufacturers, it has required increasing purchases from merchant firms to supplement its captive production. In 1980, it was reputed to be looking to the open market to provide 25-30 million 16K RAMs, about 50 per cent of the industry's 1979 production ([30], p. 47).

While the Japanese might gain sufficient competitive advantage in 64K RAMs (or later 256K RAMs) so that United States semi-conductor firms would want an OMA, their possibility of getting one would depend largely on the reaction of the computer industry. Lately, the computer industry has been

relatively protective of its domestic suppliers. But if protection meant significantly higher semi-conductor costs and if Japanese computer advances made international price competition a more salient factor in the computer industry, it is hard to imagine the United States endangering the competitiveness of its "internationally competitive par excellence" computer industry in order to protect the semi-conductor industry's least competitive lines. Since semi-conductor producers themselves depend so heavily on the re-importation of assembled chips, a move in the direction of increased protectionism on their part appears unlikely to begin with.

Possibilities of "sunrise" industrial policies to stimulate growth of the industry

Traditionally, the Department of Defense has had the primary role in shaping United States industrial policy in the electronics industry. According to the United States Department of Commerce, government purchases account for more than half the total value of domestic shipments in the electronics equipment and components industry ([18], p. 232). The Pentagon's procurement needs have been a critical factor in the development of both computers and semi-conductors.

The role of the military in the development of semi-conductors illustrates both the advantages and pitfalls of this form of aiding "sunrise" sectors. On the one hand, because of the military significance of semi-conductors, the Government funded about half the research and development expenditure in the industry and provided the most important segment of the market. In the 1960s, military sales accounted for 48 per cent of all semi-conductor sales. In 1962, when integrated circuits were being introduced, the military accounted for 100 per cent of the market (Flamm [35], p. 328b). The subsidies and stimulus to growth provided under military auspices were undoubtedly critical to the emergence of United States dominance in the industry, and it is hard to imagine the kind of support the industry received being generated by any rationale other than military need. This method of stimulating "sunrise" sectors is, however, unlikely to be optimal from an economic point of view.

It can be argued that the role of defence procurement in shaping the growth of the semi-conductor industry has been detrimental to its commercial competitiveness. It is not only that products designed for military needs may not be easily adapted to commercial markets but also that the production methods developed in the context of military production may be inappropriate. Flamm ([35], p. 480) argues, for example, that the "brute force 'burn in' quality control techniques" which United States producers developed in response to military needs were "far less economic than the statistical techniques used by the Japanese". Whether or not one accepts these arguments, it is clear that one of the important differences between the United States and Japanese industrial policies toward the electronics industry is that United States industrial policy is greatly influenced by defence policy whereas Japanese industrial policy is aimed exclusively at commercial competitiveness. A good example of this contrast is provided by the very-large-scale integrated circuit (VLSIC) co-operative research programme sponsored by MITI and the very-high-speed integrated circuit (VHSIC) project sponsored by the United States Department of Defense. The MITI-sponsored project was aimed toward commercially oriented process innovations, whereas the VHSIC programme emphasized military applications ([29], pp. 83-88).

There appears to be little prospect for any "targeting" of the electronics sector by the United States Government in the immediate future. Support or subsidy for research and development would be the most likely form of targeting, and even this does not seem probable. When 16 major electronics companies met in the spring of 1982 to discuss the possibility of co-operative research and development, the salient concern with regard to the potential role of the United States Government was not whether government sponsorship was possible but whether prosecution by the Justice Department on anti-trust grounds was likely (Wall Street Journal, 1 March 1982, p. 6).

In short, while past United States policy in the form of 806.3/807 tariff breaks and support for overseas investment in the electronics industry have played an important role in shaping Latin America's relationship to the United States industry, any future changes in that relationship are more likely to be due to technological changes or the emergence of new firm strategies than to United States industrial policy.

Implications for Latin America

The basic issue as far as the future development of the electronics industry in Latin America is concerned is whether Latin America's principal role will be filling in the most labour-intensive links in the production process as organized by United States transnational corporations or whether it is possible at this time to develop an electronics industry within Latin America which includes the more knowledge and capital-intensive stages of the production process. Mexico and Brazil provide examples of the two strategies. Mexico has been quite successful in developing its participation in the production process as organized by United States transnational corporations. Brazil has been relatively unsuccessful in its attempts at national development of a more integrated industry.

Mexico - the future of export-oriented assembly

At first glance, Mexico would seem to provide a clear example of the benefits to be gained from participation in the geographical division of labour as it has been defined by United States electronics transnational corporations. By 1980 it was the primary source of television apparatus and parts for United States firms, accounting for just under two thirds of all 807 imports in this product category (see table 16), more than double the share of the two largest East Asian suppliers combined (Taiwan Province of China and Singapore) ([37], p. 43). While its exports of semi-conductors were not large relative to the exports of East Asian suppliers, about one sixth of the exports of Malaysia, the leading supplier ([34], p. 28), they still accounted for a substantial portion of Mexico's 806.3/807 exports.

A slightly longer-term examination of Mexico's electronics exports reveals the problems of the export-oriented strategy. This is particularly well illustrated by the case of 806.3/807 semi-conductor exports, as shown in table 17. In the late 1960s and early 1970s, Mexico's share of 806.3/807 semi-conductor exports was expanding and Mexico had a virtual monopoly on offshore semi-conductor assembly in Latin America. In the early 1970s, increasing competition from Asia began to erode Mexico's share. Then, in 1976, a combination of devaluation, strikes and work stoppages, and political uncertainty appears to have stimulated a major

Table 16. Mexico as a source of 807 imports of television receivers and parts, 1977-1980

	1977	1978	1979	1980
Total United States imports	1 367	1 817	1 854	2 125
807 imports	451	745	865	941
Mexican share of total imports (percentage)	16	21	30	30
Mexican share of 807 imports (percentage)	48	51	64	66

Source: United States International Trade Commission, Imports Under Items 806.30 and 807.00 of the Tariff Schedules of the United States 1977-1980, USITC Publication 1170 (Washington, D.C., 1981), pp. 42-43.

shift in transnational corporation attitudes toward Mexico as an offshore assembly site for semi-conductors. Its share dropped first to 11 per cent and then to 5 per cent. By 1978 El Salvador and Barbados together were exporting more 806.3/807 semi-conductors to the United States than Mexico was.

Significant shifts in transnational corporation investment strategies in semi-conductors had preceded the declines in Mexico's share of exports. Finan's data on establishments of offshore assembly sites by a sample of 32 United States semi-conductor firms (cited in Flamm [35], p. 367b) shows that there was already a shift away from Mexico in the early 1970s. Of roughly 15 assembly operations established in Latin America prior to 1972, 80 per cent (12 operations) were in Mexico; of 8 assembly operations established between 1972 and 1974, over 60 per cent (5 operations) were outside the country.

The shift of United States semi-conductor operations from Mexico to the countries of the Caribbean where wages are even lower graphically demonstrates the problematic nature of an industrial strategy, which relies too heavily on fitting into the international division of labour as defined by transnational corporations. The option of participating may well be contingent on controlling both wages and the domestic political predictability. The economically disruptive consequences of the transnational corporations' negative evaluation of a particular country may in turn result in a self-fulfilling prophecy as their withdrawal creates further reason for economic and political instability.

Despite the risks involved, there remain, of course, powerful incentives for participating in export-oriented assembly operations in the electronics industry. The prospects for participants in semi-conductor assembly have already been mentioned: the market is growing very rapidly even though the share of foreign value added seems to be falling. In the

Table 17. Latin American shares of 806.3/807 semi-conductor exports to the United States a/
(Percentage share of market)

Country	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Mexico	22	26	28	21	19	20	18	11	6	5
El Salvador	--	--	--	--	--	--	--	1	3	3
Haiti	--	--	--	b/	b/	1	b/	b/	1	1
Barbados	b/	--	b/	--	b/	b/	b/	b/	1	3
Netherlands Antilles	1	b/	b/	1	b/	1	b/	b/	--	--
Brazil	--	b/	b/	--	--	b/	1	1	1	1
Latin America	24	26	28	22	19	22	20	15	12	13

Source: Kenneth Flamm, "Offshore production in the international semiconductor industry", The Internationalization of Industry, Grunwald and Flamm, eds. (Washington, D.C., Brookings Institution, forthcoming), p. 370a.

a/ Calculated from magnetic tape provided by the United States International Trade Commission.

b/ Less than 1 per cent.

case of television receivers and parts, the market is growing more slowly, but the share of 807 imports relative to total imports seems to be growing, at least in the most recent period (see table 16).

Since United States policy on 806.3/807 imports is unlikely to change, only a combination of changes in firm strategy and technology is likely to undermine the position of electronics as a foreign exchange earner. In the absence of such changes, the probable evolution of United States industrial policy would seem likely to increase the attractiveness of electronics as an export industry. Increasing protectionism in industries in which trade is not so thoroughly integrated into the production strategies of United States transnational corporations is likely to make trade in electronics an avenue of lesser resistance and therefore a likely prospect for expansion.

Whether the expansion of export-oriented electronics should be considered a positive development from the point of view of Mexico's overall industrial development is open to debate. Electronic assembly operations are unlikely to be the basis of a more vertically integrated industrial development in the future. In semi-conductors, the technological barriers to either forward or backward integration are a serious obstacle. It is, in fact, not at all clear that the presence of offshore assembly operations significantly facilitates the acquisition of the technology and experience that would be necessary to move into wafer fabrication. The high degree of transnational corporation control over the industry presents an additional obstacle. While locally owned firms might be willing to try to integrate forward or backwards, transnational corporations have little motivation for doing so. There is some possibility of forward integration from consumer electronics assembly, but the result would be a luxury consumer goods industry (e.g. television receivers) with few linkages to other industrial developments.

There is a strong contrast between the probable linkage effects of building exports around electronics assembly and those to be expected from building them around petrochemicals. Installing basic petrochemical capacity is very likely to bring the development of a variety of immediate and final product capacity in its wake. The institution of electronics assembly operations is unlikely to have a stimulating effect on other industries, either forward or backward.

The development of export-oriented electronics manufacture is a strategy that will create few tensions with United States firms or with United States industrial policy. It also offers some positive effects in terms of job creation. But, because it is vulnerable to shifts in transnational corporations' evaluation of the local investment climate, because it has so little prospect of generating forward or backward linkages, and because the skills that can be acquired by those who work in it are limited, it is an avenue of growth that does not seem likely to have strong positive implications for overall industrial development.

Brazil: the pitfalls of trying to create an integrated local electronics industry

In 1977, Brazil decided that its dependence on transnational corporations in the computer industry was intolerable in terms of its long-run goals of industrial development. A State-owned company (COBRA) was created to produce mini-computers using technology provided by a small United States firm. Four locally owned companies were also allowed to

produce mini-computers, but transnational corporation subsidiaries were restricted to micro-computers and larger computers. This bold nationalist venture in the electronics industry was a response in part to the unwillingness of major computer companies to enter into joint ventures that would provide local partners with real access to their technology (see Evans [23]). It may also have been stimulated by observation of the high degree of transnational corporation domination in other branches of the electronics industry. Eight firms, all transnational corporation subsidiaries, control 75 per cent of Brazil's production of electronic components ([36], p. 101).

By 1982 the success of Brazil's initiatives had proven unsatisfactory. Four out of five mini-computer firms were operating in the red (Business Latin America, 20 October 1982, p. 335). Transit, the firm which was supposed to produce components and allow the mini-computer firms to integrate backwards, was bankrupt (Latin America Weekly Report, 29 October 1982, p. 8). Users of mini-computers were forced to pay prices between three and a half and four times higher than world market prices and were offered equipment reputed to be "at least a generation behind the state of the art" (Business Latin America, 20 October 1982, p. 335). Micro-computers produced by transnational corporations had taken over a substantial portion of the market share previously held by mini-computers, and a growing market in smuggled computers had developed. High-priced, technologically backwards data processing obviously had a negative effect on the efficiency of businesses in general. If the policy does not result in a viable, locally controlled computer industry, then the costs will have been substantial and the benefits dubious.

The example of the computer industry should not be taken to indicate the impossibility of nationalist strategies in the electronics industry. Brazil has been quite successful in its attempts to "Brazilianize" the telecommunication industry (Business Latin America, 15 September 1982, p. 292). The problems in the computer industry do, however, make clear the difficulties of trying to overcome a large technological gap without any co-operation from the transnational corporations that control the technology. Joint ventures of the kind that Brazil has succeeded in developing in the petrochemical industry might have provided a solution, but the extremely strong technological position of transnational corporations in the computer industry makes it possible for them to avoid such shared control.

The likelihood of any United States industrial policy reducing the problems confronting nationalist attempts like Brazil's is very small. Openness to imports is not an issue since international competitiveness is beyond the grasp of the Brazilian computer industry. There is no possibility of policies designed to encourage transnational corporations to enter into joint ventures that would involve sharing technology. Should the United States step up attempts to promote computer exports in the future, Brazil's policies would also certainly be critized. Both trade barriers and restrictions on transnational corporation investments are likely targets if the United States should decide on a policy designed to take fuller advantage of its strong international position in the computer industry.

Brazil's more nationalist electronics strategy is more likely to result in conflict with eventual United States industrial policy than Mexico's export-oriented strategy. It is not clear, however, that

Brazil's policy offers in compensation greater possibility of a broadly positive impact on the overall industrial development.

The representativeness of the illustrative industries

Looking at the changing structural position of United States manufacturing and the corresponding United States industrial policy through the lens of only three industries opens the possibility of a biased view. How representative are the industries that have been examined here? To what extent can they really be considered illustrative of the overall situation of United States manufacturing? How might consideration of other industries modify the conclusions reached so far? A brief consideration of these broader issues is the necessary precursor to an examination of the possibilities for the future interaction of the United States and Latin American manufacturing sectors.

The representativeness of the illustrative industries

Two of the illustrative industries (petrochemicals and electronics) are taken from the growing (as opposed to stable or declining) industries. In fact, the industrial categories from which they are drawn (Standard Industrial Classification (SIC) 28 and 36) have expanded their share of output more rapidly than any of the other categories, and together they accounted for half the output of the "growing industries" in 1979. Focusing on these sectors should have provided ample opportunity for uncovering United States policies designed to stimulate or promote "sunrise" industries.

The third industry, steel, provided a counterbalance to the first two. Primary metals (SIC 33) lost a larger share of total output between 1959 and 1979 than any other industrial category. The inclusion of steel ensured that our small sample covered the gamut from growth to decline. Given the salience of the steel industry in policy terms, steel provides a very good case for the examination of policy towards declining sectors.

The industries selected also illustrated range of experience with regard to United States trade patterns. The computer industry exports an unusually high proportion of its output (see table 13). Petrochemicals are also important as an export industry. Failure to export coupled with high import penetration is a problem for steel. Consumer electronics is a prime example of high import penetration. Semi-conductors offer a unique example of an industry in which both import and export coefficients are high due to the extreme extent to which the production process has been internationalized.

The illustrative cases did not provide a good range with regard to the position of labour. The classic labour-intensive industries whose share of total employment is higher than their share of output - textiles and apparel - were not included. All of the industries that were included were relatively capital-intensive, characterized by a higher value added per production-worker hour than the average for all manufacturing (see tables 5 and 14). The only one of the three industries in which the level of wages is a primary issue in competitiveness is steel,* and here wages are an issue more because they are high relative to value added than because typical United States manufacturing wages would make the industry uncompetitive. (Production workers in steel receive an hourly wage that is 60 per cent higher than production workers in the computer industry but produce a value added that is 50 per cent lower.)

Given the capital-intensive character of the illustrative industries, the kind of policy issues raised by low-wage, labour-intensive industries like textiles and apparel have not been broached as thoroughly as might have been warranted. Since such industries are also those most likely to generate protectionist responses (see Anderson and Baldwin [38]; Franko [9]), the discussion may then have had a tendency to underestimate the role of protectionist responses in the overall contours of United States industrial policy. Careful consideration of the situation of other industries suggests, however, that this is not as serious a distortion as it might first appear.

The lessons of industries not considered

Questions of wages and their implications for competitiveness are usually salient in discussions of the international aspects of United States industrial policy. The special example of a threatened United States industry is textiles/apparel, in which wages, already low by general United States standards, are still too high to allow the industry to compete without substantial barriers to the entry of imports, particularly from the newly industrializing countries. Despite speculative attempts to find technological answers to problems in these industries, the possibilities for technological changes are limited. Consequently, the choice between protection or decline is more clear-cut.

Is it not the case then that prognostications regarding the future contours of United States policy should focus more heavily on these "sunset" industries? For two reasons, this question should probably be answered in the negative. First of all, low-wage, labour-intensive industries already represent a relatively circumscribed segment of the manufacturing sector, one with therefore rather limited overall political influence. Perhaps even more important, decisions regarding governmental support for the low-wage, labour-intensive industries have for the most part been taken; either for protection, as in the case of textiles (which has done quite well under its umbrella), or not, as in the case of footwear.* These industries still provide an important reservoir of potential demand for protectionist measures which should not be ignored. But whether their preferences will be reflected in overall future policy depends more on the degree to which they can gain support from other sorts of industries than on the future evolution of these industries themselves.

Perhaps the most important source of future allies are what might be called the "high-wage uncompetitive" industries, of which steel is the archetype. The salience of this category has increased with the shifting situation of the auto industry as firms invest heavily in increasing productivity and in new products designed to meet foreign competition but also move in the direction of supporting protectionist solutions. If a trend towards protectionism builds up, the political weight behind protectionist policies is substantially increased. The recent passage by the United States House of Representatives of a resolution calling for "local content" restrictions is an indication of just how critical the auto industry can be in shifting overall policies with regard to international trade issues.

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*Wages are also an issue in consumer electronics, but not the primary determinant of competitiveness. In semi-conductors, United States wage levels do make certain phases of the production process non-competitive, but the industry as a whole remains competitive.

The main lesson to be gained from considering other industries is that the case of the steel industry should not be looked upon as an exception. The momentum toward protectionist policies that can be seen in the steel industry case must be taken very seriously. This is not to say, however, that the analysis of future industrial policy should be focused more heavily on victims of import penetration, or even on more recent victims like the auto industry. Transnational corporations remain the most important reservoir of political pressure on issues relating to the international economy (see Helleiner [40], p. 23). Petrochemicals and electronics will generate fewer headlines around issues of international trade and industrial policy than steel or autos, but it is the expanding transnational capital in industries like chemicals (oil) and electronics that are likely to have the largest influence in generating future industrial policy, particularly in so far as it has international ramifications.

Overall contours of future United States industrial policy

The central inference to be drawn from the illustrative industries is that prospects for positive adjustment policies in the future are not encouraging. The industry case studies have illustrated this in two ways. First, in industries where the chances of enhanced international competi- tiveness are reasonable, there is no indication of any past attempts or future intentions at policies aimed at maximizing competitive potential. In petrochemicals there is no indication of any policies designed to com- pensate for the loss of international competitiveness that must inevitably follow from decontrol of raw materials prices. In semi-conductors there is no evidence of any attempt to counter the financial pressure under which firms find themselves as a result of severe price competition com- bined with escalating capital requirements.

On the other hand, the steel industry shows clearly the lack of creative policy response even when industrial distress is chronic and extreme and when ad hoc protectionism (voluntary restraint agreements and trigger price mechanisms) has not been successful in revitalizing the industry. The Youngstown community steel corporation, one of the more innovative responses, was not granted a loan guarantee from the Economic Development Administration. There has not been any major attempt to devise a policy for a more rational and less socially disruptive "shrinking" of the steel industry, which would seem to follow from Crandall's [2] very convincing analysis.

Positive adjustment policies can be found neither in potentially competitive industries nor in clearly declining ones. Efforts at piecemeal protectionism are likely to continue, perhaps attenuated in some areas by general free trade preferences, or perhaps intensified by requests for protection from a growing number of industries.

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*It is also important to keep in mind that the firms which remain, even in industries like footwear, have become differentiated. The larger, more successful ones have developed internationalized strategies, not unlike those of firms in consumer electronics (see Evans [39], pp. 302-336).

Implications for Latin America

The implications of the current situation for Latin American manufacturing are relatively straightforward, and not particularly encouraging. From United States policy little support can be expected. If a recovery of demand for manufactured goods in the United States economy depends on industrial policy, it is unlikely to occur. Therefore, in so far as Latin Americans might hope for growth of demand in the United States economy to expand markets for manufactured goods, their hopes will have to rest with other kinds of policy (e.g. fiscal and monetary policy) or with a cyclical upturn unrelated to policy.

There is little prospect, at least through the mid-1980s, that policies stimulating the shift of capital and labour into more technologically advanced and internationally competitive sectors might relieve pressures for protectionist barriers against Latin American exports in industries in which the United States is no longer competitive. On the contrary, there is even the possibility that protectionist pressures might spread to industries whose competitive position has been traditionally strong, like petrochemicals.

Finally, there is no convincing evidence that even in industries characterized by substantial internationalization transnational corporations will provide reliable allies for Latin American manufacturing sectors in conflicts with United States domestic interests. The degree to which United States auto manufacturers appear to be willing to modify their pro-free trade stance, after having spent a good deal of the 1970s developing strategies which involved an internationalization of the process of production of autos, is a case in point. The fact that the future strategies of oil and chemical transnational corporations, to the extent that they move in the direction of promoting imports of basic petrochemicals into the United States domestic market, may serve more as a means of access for Middle Eastern rather than for Latin American production is a second case in point. Finally, in the electronics industry, where transnational corporations appear to have tied their fortunes most thoroughly to third-world manufacturing, the prospects for growing Latin American participation appear very limited. The rush to set up new offshore assembly facilities has abated, the proportion of offshore value added in 806.3/807 imports is falling, and the spectre of a turn towards greater emphasis on onshore automated assembly is real.

The longer-term prospects for the interaction of the United States and Latin American manufacturing sector will depend to a large degree on whether current policy trends persist past the mid-1980s. If they do not, there are substantial possibilities for more positive, mutually supportive interaction, but there are also substantial possibilities for more serious deviations from reciprocal growth patterns.

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THE POTENTIAL FOR SOUTH-SOUTH TRADE IN CAPITAL GOODS INDUSTRIES

Jeffrey Nugent*

Criteria for determining the potential for South-South trade and industrial development

While considerable attention has been given in the existing literature to the determinants of the international division of labour in general and of North-South trade in particular,** very little has been devoted to the determinants of South-South trade. The lack of interest in the determinants of South-South trade would be more understandable if they were basically similar to those of trade in general. Recently, however, Krueger, Bhagwati and their associates have provided rather convincing evidence that the determinants of South-South trade are in fact quite different from those of North-South trade (Krueger [2, 3, 4], Bhagwati [5], and Corbo and Meller [6]). For example, Corbo and Meller [6] have shown that variations in factor endowments between different countries, together with variations in factor-intensity between different sectors, explain the nature of both southern exports to the North and northern exports to the South but not the nature of South-South trade. While southern exports to the North tend to be relatively labour-intensive and southern imports from the North relatively capital-intensive (at least after standardizing for other factors such as skills and land), southern exports to the South cannot be characterized in any such way.

If the determinants of South-South trade could not be satisfactorily explained, it would be difficult to identify specific sectors with a potential for South-South trade and industrial development. Since industrialization has long been viewed as the primary, if not exclusive, motive for South-South co-operation, this would be a serious shortcoming (Cooper and Massell [7], Johnson [8] and Balassa [9]).

However, Yeats ([10], chapter 3) has recently suggested that southern exports to the South should be labour-intensive despite the evidence that at present they are not. He has proposed that the South-South trade potential of all southern manufactured goods based on a labour-intensive technology could be measured by reference to the smaller of the total values of southern imports from the North and of northern imports from the South. Since for most manufactured commodities the value of northern

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**Indeed, virtually all of the enormous literature on international trade theory has been devoted to this issue, with the classical, neoclassical and product-cycle theories standing out as particularly important alternative explanations. See for example Caves and Jones [1].

exports to the South greatly exceeds the value of southern exports to the North, the proposed measure of South-South trade potential is in almost all cases the current value of southern exports to the North. Applying this measure to a group of industries identified as labour-intensive in previous studies, Yeats found the potential for South-South trade in industrial products to be only a small fraction of current imports of the South from the North.

Although the suggestions by Yeats that the assessment of potential South-South trade in manufactures should be based on the potential for import substitution measured by actual or projected imports of the South from the North and on some measure of demonstrated competitiveness are both useful, neither labour-intensity nor the level of existing southern exports to the North would seem appropriate as measures of competitiveness. We propose that, instead of the labour-intensity of technology, the criterion for potential development of South-South trade and co-operation should be that production is intensive in the use of factors which are available in sufficient quantity and quality in the South as a whole, although not in any single country of the South. Likewise, above-average growth rates in both production and exports by the South to the North should replace actual exports as a measure of demonstrated competitiveness.

In view of the influence of dynamic factors on both the determinants and the effects of trade, attention will be focused, not on those sectors characterized by high rates of new product development, but on those in which the learning-by-doing benefits of production are particularly important. Such an approach is adopted because the ability to compete successfully in product innovation requires investments in research and development, high-quality scientific communities and a sophisticated and competitive institutional environment, including patenting and copyright systems, which will probably remain beyond the capabilities of developing countries in the near future. Learning by doing is important because there is no substitute for experience in production so far as concerns long-term labour skills, managerial development and technical efficiency. Such benefits may often be substantial and take the form of externalities not reflected in the ordinary calculus of internal benefits and costs.

Table 1 contains various indicators of the criteria for assessing the potential development of South-South trade and co-operation in manufacturing activities numbered according to the International Standard Industrial Classification of all Economic Activities (ISIC) and grouped into the five major industrial branches of food processing, light industry, basic products, coal and petroleum products and capital goods.

As reflected in the table, food-processing industries tend to make but little use of scarce resources, although in terms of capital-intensity they are above-average in one of the indicators. More importantly, however, as shown in the last column, the share of imports from the North in apparent consumption is less than 10 per cent for each such industry. This sector therefore seem quite unpromising for development of South-South co-operation.

All the light industries are shown to be below average in energy-intensity and all except ISIC 342 (printing and publishing) and ISIC 381 (metal products) are low in skill- and human-capital-intensity. Only ISIC 355 (rubber products) is above average in capital-intensity. ISIC 342 (printing and publishing), however, can be ruled out because it has both

Table 1. Criteria for potential development of South-South trade and co-operation

ISIC	Industrial grouping	Indicators of intensity in resource use							Index of new product development	Share of imports from the North in consumption of the South (percentage)
		Energy	Skilled labour	Human capital	ICOR		Capital a/ K/L	VA/L		
					Developed countries	Developing countries				
	Food processing	0.039	..	..	0.99	0.60	..	112	..	0.082
311-312	Food manufacturing	0.050	..	..	1.46	0.82	..	103	..	0.095
313	Beverages	0.034	..	..	0.60	0.48	..	150	..	0.069
314	Tobacco	0.034	..	..	1.13	0.25	..	179	..	0.042
	Light industry	0.050	L	18.6	0.76	0.91	8.30	72	..	0.172
321	Textiles	0.043	L	17.8	0.98	1.32	9.40	64	L	0.148
322	Wearing apparel	0.043	L	12.0	0.46	0.49	2.02	49	L	0.092
323	Leather	0.025	L	17.3	0.76	0.63	5.86	53	L	0.088
324	Footwear	0.025	L	..	0.60	0.45	..	..	L	0.071
331	Wood	0.054	..	12.2	0.97	1.09	11.27	59	..	0.108
332	Furniture	0.054	L	21.7	0.63	0.76	4.52	68	L	0.150
342	Printing	0.055	H	36.2	0.63	0.66	8.42	94	H	0.086
355	Rubber	0.087	L	18.6	1.23	0.70	10.19	102	L	0.245
356	Plastic	0.087	L	18.6	0.72	0.88	10.19	83	H	0.343
381	Metal products	0.039	H	27.9	0.90	0.65	9.07	93	L	0.255
	Basic products	0.216	..	25.5	1.86	1.18	28.85	129	..	0.303
341	Paper	0.055	..	30.1	1.72	0.68	32.94	115	..	0.261
351	Industrial chemicals	0.195	H	30.1	2.20	1.90	32.94	116	L	0.416
352	Other chemicals	0.195	H	40.1	0.96	0.38	57.61	105	L	0.113
361	Pottery	..	L	33.0	1.91	2.61	41.42	193	L	0.046
362	Glass	..	L	33.0	1.18	0.69	41.42	193	L	0.176

continued

Table 1 (continued)

ISIC	Industrial grouping	Indicators of intensity in resource use: Energy	Skilled labour	Human capital	ICOR: Developed countries	ICOR: Developing countries	Capital a/ K/L	VA/L	Index of new product development	Share of imports from the North in consumption of the South (percentage)
369	Non-metallic minerals	0.198	L	10.0	1.94	1.42	11.04	100	L	0.125
371	Iron, steel	0.415	L	10.0	2.47	2.04	11.04	154	H	0.446
372	Non-ferrous metals	0.415	..	10.0	1.67	1.27	11.04	154	..	0.434
	Petroleum and coal products	3.495	..	65.6	1.09	0.98	126.11	220	..	..
353	Petrol refining	1.868	..	65.6	1.39	1.06	126.11	220	..	..
354	Petroleum and coal products	5.122	..	65.6	1.04	0.70	126.11	220	..	..
	Capital goods	0.035	H	28.4	0.77	0.69	9.68	107	..	0.603
382	Non-electrical machinery	0.029	H	290	0.72	0.75	10.04	105	L	0.461
383	Electrical machinery	0.034	H	30.8	0.75	0.70	7.12	96	L	0.471
384	Transport equipment	0.041	L	27.1	0.86	0.73	11.60	122	H	0.757
385	Scientific instruments	..	H	41.2	0.86	1.21	11.15	117	H	1.264
390	Other	0.057	L	17.8	0.60	0.59	5.67	81	H	..
	Whole economy	0.104	..	28.3	0.99	0.89	20.52	107	..	..

Sources: 1975 input-output table for France in the UNIDO data base; information supplied by the Office of Development Research and Policy Analysis of the United Nations Secretariat for the period 1967-1977; World Industry in 1980 (United Nations publication, Sales No. E.81.II.B.3), pp. 103-108; B. Balassa, "A stages approach to comparative advantage", Economic Growth and Resources: National and International Issues, I. Adelman, ed. (London, Macmillan, 1979); and H. Lary, Imports of Manufactures from Less Developed Countries (New York, National Bureau of Economic Research, 1968).

Note: H and L represent high and low, respectively. For criteria used in such classifications, see the original studies.

a/ Incremental capital-output ratio (ICOR); ratio of capital to labour (K/L); ratio of value added to labour (VA/L).

a high index of new product development and less than a 10 per cent share of southern imports from the North. With the exception of rubber and metal products, light industry in general would not seem promising for the development of South-South co-operation.

With respect to basic products, all commodity groups except paper are energy-intensive, and all are either skill- or human-capital-intensive, on the one hand, or physical-capital-intensive, on the other, or both. All except ISIC 361 (pottery and china) have shares of southern imports from the North in excess of 10 per cent, and only ISIC 371 (iron and steel) has a high rate of new product development. Except for these two commodity groups, therefore, basic industries would seem relatively promising for development of South-South co-operation.

Coal and petroleum products, which are similar to basic products in the sense that they are derived from mineral and fuel processing industries, are intensive in resources that are scarce in some regions of the South. However, this industry is already relatively well developed in the South as a whole and has reached a considerable degree of specialization in North Africa and the Middle East.

Capital goods industries are not energy-intensive but tend to be above average in skill- and human-capital-intensity, and in some commodities are also physical-capital-intensive. Although ISIC 384 (transport equipment) and 385 (scientific instruments) are classified as high in rates of new product development, the last column shows that in all commodities in this grouping an exceptionally high proportion of imports from the North is consumed. With the exception of ISIC 385 and 390, therefore, capital goods industries would appear especially promising for development of South-South co-operation.

While there is no comprehensive index of learning-by-doing available for all industries, the machinery and other engineering industries -- usually including metal products which are here classified among the light industries - are almost invariably considered to rank among the highest. The learning-by-doing benefits add to the potential of capital goods and rubber and metal products as priority industries for the development of South-South co-operation.

Capital goods industries: the primary focus for intra-South co-operation and industrialization during the 1980s

While there are many other areas of manufacturing in which the South may be able to make significant progress in industrialization in the coming decades, there is none so important in quantitative potential, so central to reducing excessive and semi-permanent technological dependence on the North, or so vital to the overall development of the South as its capital goods industries. At the same time, while import substitution at the national level has served and will continue to serve as a vehicle for industrial growth of some industrial sectors in the South, especially finished consumer goods, and while exports to markets in the North may stimulate growth in raw-material-processing and light industries, neither strategy is viable or appropriate for capital goods industries. On the one hand, the growth of any such industry in the South requires a large-scale market, a degree of specialization and division of labour, and especially a level of sophistication in marketing and technical know-how that would exceed the scope of even the most ambitious national

development plans of developing countries. On the other hand, since a major, though not necessarily dominant, reason for the development of capital goods industries in the South is to develop capital goods that are more appropriate to the relative factor endowments and small-scale conditions of developing countries, and since the most rapidly growing markets for capital goods are in the South, it is appropriate that markets for their output should be sought primarily in the South. The development of capital goods or engineering industries would therefore seem beneficial and feasible only within a programme of South-South co-operation in which they would be one of the principal fields of activity.

The following matters are dealt with in the remaining parts of this study: the rationale for the development of capital goods industries in the South; obstacles to the development of such industries and the means of overcoming them; and recent experience in production and trade of developing countries, with a view to identifying specific capital goods for which there exists potential for development of South-South co-operation.

A. General rationale for capital goods as the focus of industrial development and South-South co-operation during the 1980s

The overall share of the South in world exports (at current prices) had reached more than 30 per cent by 1978 and has apparently risen slightly since then. Indeed, the proportions of world exports of agricultural and energy products accounted for by the South are considerably higher (currently about 36 per cent and 70 per cent, respectively). Only in the export of manufactures is the share of the South relatively low (about 10 per cent). In particular, it is 18 per cent in consumer non-durables, 9.5 per cent in intermediate goods and 9 per cent in consumer durables. In contrast, the share of the South in world exports of capital goods was only a little over 6 per cent as recently as 1979. Likewise, although the share of the South in world consumption of capital goods is high and rising, its share in world value added in the capital goods industries, barely 5 per cent as recently as 1979, lags far behind that of the South in all other sectors, including the other manufacturing sectors, where it exceeds 10 per cent. The overall weakness of developing countries in the capital goods industries appears even greater when it is noted that, because of the concentration of southern capital goods production in the 10 to 12 newly industrializing countries, most developing countries have no capital goods industry at all [11].

Although southern demand for capital goods represents over 20 per cent of world demand, imports of capital goods by the South amount to an estimated 30 per cent of the world total because its production and exports of such goods both remain low. Hence the development of capital goods can be considered an important and indeed strategic element for the development of the South. Special attention has been devoted to it at various international conferences, including the Second and Third General Conferences of UNIDO, which adopted, respectively, the 1975 Lima Declaration and Plan of Action on Industrial Development and Co-operation, and the 1980 New Delhi Declaration and Plan of Action [12, 13]. Such plans, however, have yet to be either fully justified on economic grounds or articulated into a feasible programme. Nor has the potential role of South-South co-operation been sufficiently dealt with.

While the weakness of the South's capital goods industries may be rather clearly established, this is hardly sufficient for justifying their development as a priority for the South and the international community. As pointed out previously, capital goods production tends to require inputs which are available in sufficient quantity and quality not in any one region of the South, but in the South as a whole. Is it then possible to justify the high priority given to capital goods production in the South? And is it feasible and efficient for the South to produce its own capital goods? In the following paragraphs, we argue that the answer to these questions is yes. There are several reasons for believing that these sectors fully deserve priority treatment both for industrial development of the South and for South-South co-operation. The arguments are presented under the following three headings: static efficiency, dynamic efficiency and appropriate technology.

(a) Static efficiency

In terms of labour productivity of developing countries relative to that of developed countries, and employment per unit of capital as a measure of labour intensity, capital goods industries are generally no better than average (Pack [14], Mitra [15], UNIDO [16]). Most studies assign priorities among industries for development by the South on the basis of traditional static criteria such as relative factor productivity or factor-intensity. In both respects capital goods industries, at first glance at least, do not appear particularly attractive,* thereby accounting in part for the exceptionally low shares of the South in both production and exports of capital goods.

Nevertheless, there are several factors that should be taken into account. First, while capital goods industries as a whole are of only average labour-intensity among manufacturing industries, the variation in labour-intensity is so large that some subsectors, such as agricultural, office and metal-working machinery and ships and boats, are among the most labour-intensive of all industries (Rahman [17], Lary [18], Hufbauer [19], UNIDO [11, 16]).

The second factor concerns economies of scale. The dominance of industries by large firms is usually regarded as indicative of the importance of economies of scale. The existence of such economies is, in turn, considered to make it difficult for developing countries, especially those characterized by small markets, to compete with developed countries which, because of their greater market size, are better able to take advantage of the economies. However, there are in fact numerous capital goods, such as woodworking machinery, conveyors, dies, tools and jigs and machine tool accessories, in the production of which small firms dominate and economies of scale are not an important factor (Mitra [15]).

Thirdly, even within subsectors of the engineering or capital goods industry, studies conducted in developing countries reveal a great deal of variation in efficiency and cost from one firm to another. Such variations underscore the importance of establishing comparative costs, management efficiency comparisons and other firm-specific characteristics (X-efficiency etc.) in relation to the more traditional determinants of such costs, namely factor proportions. Some capital goods producers in

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*See for example the not particularly low levels of capital and skill intensity of this sector as shown in table 1 above.

developing countries are, therefore, bound to be competitive even in the less labour-intensive subsectors (Mitra [15], Pack [14]).

It may thus be concluded that factor intensity, relative factor efficiency and economies of scale cannot be considered fundamental obstacles to the development of capital goods in developing countries. Some capital goods subsectors are labour-intensive and yet not characterized by economies of scale. Static efficiency would seem to depend to a much larger extent on more particular factors, such as quality of managerial personnel, plant layout, and availability of information, rather than upon factors more closely associated with traditional (neo-classical) trade and development theory. Even currently inefficient or unprofitable firms may become efficient and profitable with improved management, better information, better plant layout etc.

This does not necessarily mean that static efficiency considerations would make all or even any capital goods industries viable in all developing countries. Indeed, there are other factors that may well limit the number and type of developing countries in which anything more than the most rudimentary capital goods sector can be developed. Most importantly, many capital goods subsectors tend to be skill-intensive, that is, they require large amounts of skilled labour which frequently is in short supply in developing countries. However, some developing countries, such as Argentina, Egypt, India, Lebanon, Pakistan and Singapore, have an abundant supply of skilled labour, for which the low wage advantage of developing countries is even greater than in the case of unskilled labour. There are also some capital goods, such as railway cars, trailers, trucks and hand tools, the production of which requires fewer skills [16], and which therefore may be both feasible and economic in countries not well endowed with skilled labour.

In general, even on the basis of traditional static efficiency considerations, there is little reason to doubt that at least some types of capital goods could be produced and exported by most developing countries and that substantial capital goods sectors could be developed in those countries of the South with especially low wage rates and ample supplies of skilled workers and good managers.

(b) Dynamic efficiency

The division between static efficiency and dynamic efficiency is an arbritrary one. In the above discussion of static efficiency mention has already been made of the fact that plant layout, management and other elements of non-traditional static efficiency are likely to be of greater importance in determining the viability of capital goods production in developing countries than the traditional sources of static efficiency, such as factor proportions. A crucial ingredient of the efficiency of a firm at a given time is its utilization of the physical and human capital at its disposal (Mitra [15], Pack [14]). Since market insufficiency tends to be a major cause of underutilization, and since market penetration requires both time and investment in sales promotion, the attainment of efficiency may be seen as a dynamic process. This is particularly true in the case of capital goods because the ability to market depends to a large extent on experience in their use, including the cost and timeliness of maintenance and the availability of replacement parts.

Since many capital goods subsectors involve relatively unstandardized goods, for example, machines of different size, power and function, the market for any one of which may be rather small, it may be possible to increase the utilization and efficiency of plants producing capital goods by making several product lines within a single plant. On the other hand, there are down-time costs involved in switching from one product line to another, which implies that efficiency can usually be increased by lengthening the duration of production runs and by concentrating on fewer product lines. This can be done by increasing either market size, through penetration of new markets, or the degree of specialization in satisfying given market demand through a system of subcontracting or the co-ordination and specialization that can be arranged by transnational corporations (TNCs).

By and large, engineering or capital goods industries are characterized by a substantial amount of learning by doing (Hirsch [20], Alchian [21], Rapping [22], Sheshinski [23], and Dudley [24]). If the learning-by-doing benefits are derived by agents external to the firms themselves,* the resulting externalities may justify policy intervention, for example to subsidize the production and export of such industries (Mitra [15]). Nevertheless, since the source of such benefits, their magnitude and the particular parties that derive them all vary considerably from case to case, each must be thoroughly investigated before the appropriate policy can be determined. As a general rule, the learning-by-doing benefits tend to be substantial, with the implication that reductions in the social cost of production may be expected to occur as production experience accumulates. An even more common form of learning-by-doing benefits is the greater ability, derived from experience in production marketing, to innovate, to develop new products and to penetrate new markets such as those of the North. Whereas delaying entry into other industries could make it possible to take advantage of more up-to-date technology, such a delay in the capital goods industry could impose substantial opportunity costs on would-be producers in the form of lost learning-by-doing benefits.

Another dynamic benefit of capital goods industries for the South is the various kinds of linkages between such industries and other parts of the economy. Capital goods industries generally rank above average with regard to inter-industry linkages (both forward to industries using capital goods and backward to industries providing the inputs for capital goods). As already mentioned, they also involve final demand linkages, that is, linkages to skilled and unskilled labour, and thereby to the sectors producing the commodities demanded by labour. While, as Pack [14] points out, the development of capital goods in the South may be impeded by inefficient, high-cost production of the inputs to such industries, in the long run the linkages created may lead to new investment decisions or increased utilization of capacity, either or both of which may raise efficiency in the sectors involved.

Since none of the dynamic benefits is likely to be realized unless there are both incentives to take advantage of them and pressures to produce efficiently, blanket protection of infant capital goods industries

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*While this may occur in various circumstances, it frequently happens when the workers or managers who do the learning are free to move to other firms or to other countries, or when the workers or managers are recruited from abroad.

in the South is not the answer. A certain degree of openness to competitive forces must be provided in order to gain such benefits. The opening-up of the South to competition from other southern producers, while possibly maintaining some protection from northern producers, may be one mechanism for accomplishing this.

It has long been noticed that technological innovations and dynamic efficiency improvements tend to appear more frequently and to be of greater significance in growing industries than in stagnant or declining ones (Schmookler [25], Rosenberg [26]). Whereas traditional industries which have been at least partially redeployed to the South, such as textiles, leather, and wood products, are declining, capital goods industries are of rapidly growing importance in production (see table 15), employment (see table 16) and trade (see table 2) in the world as a whole, making it likely that, over the long term, there will be more innovation and technical change in capital goods industries than in others. Many of these changes are of the learning-by-doing variety which accrue only to those with experience in production.

As previously mentioned, another dynamic factor which, in the short to medium term, is likely to form an obstacle to development of industry in developing countries is high rates of new product creation or product modification. If a certain product line or subsector is characterized by a rapid rate of product modification and redesign, the greater ability of northern firms to invest in research and development will make it difficult for southern producers, even if competitive at a given time, to remain competitive over the longer term. Shorter production runs will, moreover, tend to decrease utilization rates and hence increase costs. It may therefore be wise for southern producers to avoid specialization in product lines characterized by high rates of product modification [11, 16]. As shown in table 1 above, such rates are more typical of certain capital goods subsectors, such as transport equipment (ISIC 384) and scientific apparatus (ISIC 385), than of others.

(c) Appropriate technology

A very severe constraint on industrialization and economic development of the South is the narrowness of the technological choice in terms of factor proportions and scale of production (sometimes referred to as the technological shelf) available to developing countries. As a result of this constraint, there is very little opportunity to substitute the labour which is generally available in abundant supply for capital which is in such scarce supply in most developing countries. Virtually the entire range of technological alternatives for industrial production available to developing countries is, moreover, quite inappropriate to conditions in those countries. The available technology tends to be of such capital-intensity and on such a large scale as to prevent developing countries from industrializing without at the same time increasing unemployment, income inequality and poverty. An important factor contributing to the narrowness of the technological shelf is the overwhelming concentration of capital goods production in the North. Since the share of southern markets in northern production of capital goods has until recently been small, the South has served as a minor extension of the market for capital goods produced in the North and designed for the economic conditions of the North. The small size of the capital goods markets in the South, especially at the national level, has seemed hardly sufficient to justify research and development expenditures to develop capital goods more appropriate to conditions in the South.

While it may be relatively difficult and expensive in terms of investment costs to develop an entirely new and appropriate technology, as recent experiments have demonstrated,* smaller-scale and more labour-intensive technology may be found relatively easily in the older lines of capital goods produced in the North. In some cases, the older lines are associated with significantly lower technical efficiency, implying that developing countries would have to sacrifice efficiency in order to utilize smaller-scale and more labour-intensive techniques. Such a sacrifice may not be economically or socially profitable. In other cases, however, the production of older lines of capital goods in developing countries would make it possible for southern capital goods industries to provide other southern producers with capital goods appropriate to local conditions quickly and efficiently, without requiring costly and time-consuming prior investments in research and development.

Admittedly, the available data on the ability of developing country industries to produce capital goods which are both technically efficient and more appropriate to local conditions is quite limited, and what is available hardly provides overwhelming evidence of the ability of southern industries to produce such goods. It must be remembered, however, that most of the available data on southern producers are compiled by comparatively large firms, and, as Mitra [15] and Pack [14] suggest, smaller-scale industries in developing countries are more likely to adapt technology to local conditions than either larger industries in developing countries or producers in developed countries. In part this may be explained by dualistic factor markets in which smaller firms face lower wage-rental ratios than large firms. Small firms are also less likely than large firms to be in a position to afford licensing arrangements under which southern firms gain access to foreign technology that is modern and technically efficient but also frequently inappropriate to local conditions. Without such access, small firms may well be forced to innovate with relatively simple technologies. Small-scale production also affords greater specialization, longer production runs, and fuller utilization of capacity, factors which all tend to raise efficiency and lower unit costs in the production of capital goods in the South.

While it may be difficult for southern producers to become and remain competitive when a high rate of new product development is required, this should stimulate southern industries to produce with more labour-intensive techniques and be less dependent on economies of scale than their counterparts in the North (Amsden [27], Cortes [28], Government of Pakistan [29], Pack [14]). Over time, moreover, the ability to change the imported technology to fit local conditions is likely to increase. However, in view of the importance of the technical efficiency embodied in capital goods for the productive use of such goods in the South, it can hardly be overemphasized that southern capital goods production will be viable only if it takes place in relatively open economies in which domestic producers are under continuous pressure from foreign competitors to be more efficient.

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*See, for example, the studies reviewed in the special issue of World Development, vol. 5, No. 10, October 1977.

Traditional trade theory has held that developing countries should concentrate on primary and other highly labour-intensive commodities, and modern product-cycle theory that they should focus on mature industries. However, since both types of industry are declining in importance, their redeployment to the South would have to proceed at unrealistically high rates in order for developing countries to gain and retain even a remotely adequate share of world trade and industry. There may be a statistical association between the level of development and shares in world production and trade of relatively young and growing industries. However, in view of the importance of the learning-by-doing benefits arising from the production of capital goods, any conclusion that such industries should be allocated to developed countries may be due less to logic than to the lack of experience of the South in capital goods industries. Moreover, if the South would concentrate on producing different capital goods than the North, in particular those which have factor proportions and are on a scale more appropriate to southern conditions, it may be much easier for the South to compete, at least in southern markets, than has been generally supposed.

Another factor to be considered in determining the appropriateness of southern-produced capital goods for southern markets is that of income-related quality. There is substantial evidence that the market for capital goods is rather segmented. Northern-produced capital goods are appropriate and suitable for the high-income, high-quality end of the market. But capital goods produced in the South, though cheaper, are often of lower quality and less durability than those produced in the North, and hence are more appropriate for the low-income and low-quality end of the market.* Naturally, their lower price must more than compensate for their lower quality in order to make them competitive. Nevertheless, at least for those regions of the South where repair and maintenance services are relatively cheap (the principal exceptions at present being the oil-exporting countries of North Africa and the Middle East), lesser durability and greater simplicity are not inappropriate characteristics of capital goods.

B. Obstacles to the development of capital goods industries in the South

Some examples of the major impediments to the development of capital goods industries in the South have already been mentioned. First, implicit in the importance of the learning-by-doing benefits of capital goods production is the disadvantage of being a latecomer to the industry. Second, the difficulty of creating an environment capable of generating innovations on a continuous basis in order to remain competitive with northern capital goods can hardly be exaggerated. Third, it is not always possible to produce machines more suitable to developing country conditions simply by importing older capital goods production lines from the North without paying a high cost in terms of lower technical efficiency. Fourth, some capital goods industries are intensive in inputs, such as capital and skilled labour, which are generally in short supply in developing countries. Finally, some capital goods industries are subject to high rates of product modification, requiring firms not only

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*See especially Amsden [27], Mitra [15], and Agrawal [30] for detailed demonstrations of this point.

to be in a position to finance substantial research and development, but also to possess the technical ability to reap the benefits of such experiments. Both requirements may pose substantial difficulties for producers in developing countries.

None of these difficulties is, however, insurmountable. Indeed, in each case ways of avoiding or mitigating them have also been mentioned. The means of doing so may already be available, wholly or in part, within the various regions of the South, without requiring measures of support on the part of the North.

The first difficulty pertains to the structure of relative prices, in general, and of effective protection, in particular. Since individual developing countries are small in relation to the rest of the world, domestic prices, for traded goods at least, are generally determined by foreign prices converted into local currency at the relevant exchange rate plus the nominal tariff rate on, or the tariff equivalent of existing non-tariff barriers to, such imports. The structure of domestic relative prices is thus determined in large part by the structure of nominal tariff rates - tariff rate equivalents of non-tariff barriers - across the various commodities. Since raw material and intermediate inputs are relatively important in virtually all manufacturing activities (including capital goods industries), profitability and hence the incentives for domestic production of such goods are also affected by the structure of protection of the commodity inputs. The concept of the effective rate of protection has therefore been developed to take into account both the tariff rates on the finished product and the weighted average of the tariff rates on the various commodity inputs, the weights being the relative shares of such inputs in total production. Given technology and factor efficiency, it is then the effective rate which determines the profitability of domestic value added in a particular industry. Existing studies of effective protection have tended to show that the structure of protection in developing countries is distorted in such a way as to provide extremely high rates of protection for infant-industry finished consumer goods. The corollary to high rates of effective protection for finished consumer goods production is, however, very low or even negative rates of effective protection for raw materials and capital goods industries. Low or negative effective rates for capital goods arise because the nominal rates of protection on machinery are generally low, whereas those on the intermediate inputs like steel or metal products are high. Even if the nominal rates on capital goods may not be low in the official schedules, in practice they may still be low as a result of the industrial investment incentives provided in most developing countries in the form of tariff exemptions on imported machinery. In some developing countries the relative protection of finished goods production and discrimination against the use of labour and in favour of imported capital are further compounded by discriminatory tariffs and other restrictions against old machinery. The result of such discriminatory trade and exchange rate policies throughout much of the South is that, while the use of capital goods is encouraged, capital goods production in the South is discouraged. These considerations go a long way toward explaining the underdeveloped state of southern capital goods production and the heavy technological dependence of the South on the North. The same influences, moreover, tend to make equitable, full-employment growth in developing countries difficult to achieve.

Another important obstacle to development of capital goods production in the South is the inadequacy in developing countries of activities for

financing and servicing such goods. While capital goods producers in developed countries generally have at their disposal mechanisms for financing the purchase of such goods and for servicing and maintaining them, especially in foreign markets, such mechanisms rarely exist in developing countries. This does not imply that such instruments cannot be created. It does suggest, however, that in order to be able to compete, even in southern markets, with capital goods produced in the North which are accompanied by means of financing the purchase of such goods, of maintaining them, and of replacing their components, southern producers must also be able to finance and service their capital goods.

A third difficulty already referred to is that of arranging for specialization in production so as to take advantage of both a division of labour in the form of long production runs and variations in resource endowments, without at the same time leading to underutilization of capacity, a perennial problem in such industries.

It is instructive to note that the resolution of each of these problems in no way depends on actions of the North. The South, itself, has the power to overcome or at least to mitigate the difficulties if it really wants to.* To do so, however, may require a considerable amount of co-operation among countries of the South. It is precisely for this reason that South-South co-operation is seen as the sine qua non of effective development of capital goods industries in the South. The manner in which each of these obstacles can be overcome by South-South co-operation is dealt with below.

The lack of sufficient incentives for domestic production of capital goods in the South, brought about by the low or negative effective rates of protection prevailing in developing countries, can be overcome only if such countries are willing to change their structure of protection. In view of the entrenched position of many infant producers of finished consumer goods in developing countries, it may prove politically difficult to reverse the structure of protection so as to reduce the protection afforded to producers of final consumer goods and to increase it for producers of capital goods. It could prove easier to do so within the context of a customs union in which domestic politicians could assign the blame for such changes to the requirements of an integration scheme which would compensate producers of final goods with better marketing possibilities in other southern regions. However, it is very difficult to put together and maintain effective trade agreements of this kind. Hence attempts to correct the bias against capital goods in this way may not be productive. What may be easier to achieve, however, especially in a broad context of South-South co-operation, is more realistic exchange rates. These would have the effect of lowering the relative importance of tariffs and other trade restrictions on the structure of relative prices in developing countries, thereby decreasing the degree of discrimination against southern production of capital goods. Without necessarily ensuring agreement on both a free trade area and a common external tariff rate for capital goods, the effective size of the market for southern production of such goods could be increased by having them produced by multinational companies owned jointly by various countries of the South, and inducing those countries to treat the output of such enterprises, in whole or in part, as duty-free domestic production, even if the output is actually

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*As will be discussed below, an exception is the case of the tying of northern aid to the purchase of capital goods produced in northern donor countries.

generated in another southern country. As exemptions for south- ern multinational producers of capital goods would be phased in, the incentives for new industrial investment could be phased out or down, thereby benefiting southern producers of capital goods, but without bring- ing about reductions in government revenues, as is typically the case with customs unions.

With regard to the second obstacle, the lack of a system of financing, maintaining and servicing southern capital goods deployed throughout the South in a way that would be competitive with northern producers, multinational joint ventures would also seem to be an ideal means of ensuring those vitally important functions. Specifically, such functions require finance, managerial capability and skilled labour, all of which are unlikely to be available in sufficient supply to any individual national producer. Only by drawing upon skilled labour, management and expertise from the newly industrializing countries, finance from countries exporting petroleum and other primary products, and cheap labour from other developing countries, can all the necessary ingredients of the support for capital goods industries in the South be developed.

Finally, the extremely important problem of achieving specialization, long production runs and adherence to an agreement affording domestic enterprise status to multinational joint ventures must be considered. Specialization in production requires co-ordination among different producers, and, what is more difficult for the South as a whole, co-ordination among producers in many different countries. Moreover, if producers are to be small, as would tend to be the case for successful capital goods production in the South, the problem of co-ordination is multiplied. Only large transnational corporations tend to be capable of organizing small developing country producers in this way, and even in such cases, experience has been limited to a relatively few countries which are particularly suitable for successful subcontracting, and to industries which are simple enough and have sufficiently well-known technologies and markets to make subcontracting viable (Sharpston [31]).

Licensing agreements would be an alternative mechanism for allowing for technological flows between regions of the South. However, the lack of an effective patent system in the South, the shortage of information on developing country producers and the greater importance of learning-by-doing among management and skilled workers in capital goods industries all tend to limit the usefulness of licensing agreements transferring technology from one country to another, and to underline the advantages of multinational joint ventures (Wells [32]). Arm's-length contracts between producers in different countries and especially between different developing countries, in which economic and political conditions are much more volatile than in developed countries, are exceedingly difficult to establish, monitor and enforce. By bringing the various producers and agents together within a single profit-seeking enterprise, in which all agents share the benefits arising from the fulfilment of their individual responsibilities, the costs of transactions, information and enforcement can be reduced to manageable proportions. Otherwise, it would be very difficult to see how southern producers would be able to take advantage of the benefits of specialization, small scale, full utilization of resources and resource complementarity that seem essential to a viable capital goods industry. Moreover, only if the equity capital of such multinational joint ventures of developing countries is widely subscribed to, and their activities are widely dispersed among countries and regions of the South, will their existence be regarded as equitable. Only then will countries

be willing to treat them as domestic enterprises within a de facto customs union, without going through the difficult process of formally establishing such a union.

One important obstacle to southern production and exports of capital goods which cannot be removed by actions of the South alone is that of aid-tying by the North. An important and perhaps ever-increasing proportion of bilateral official development assistance from the North to the South is in the form of tied aid requiring the recipient countries to import machinery and other components of development projects from donor country suppliers, regardless of the cost of such supplies. While in principle it may be possible for recipient countries to ban tied aid or to agree not to accept it, in practice such aid boycotts are not likely to prove successful unless the developed donor countries are willing to co-operate.

C. Potential for development of capital goods industries

The potential for development of southern capital goods industries through South-South co-operation and the types of goods involved are dealt with in this section. As a starting-point, the total current value of imports of the South from the North or perhaps even the projected value for a future target year, in this case 1990, might be taken as an extreme upper limit of the potential. Such a basis of measurement would be valid, however, only if it were realistic to assume that, for the South as a whole, it would be possible and economic to substitute for all current southern imports from the North. As shown in table 2, this measure of the potential increase in production and trade through South-South co-operation would be $99,384 million in 1978 (at current prices). If past trends continue, this value could reach $187,680 million (at 1978 prices) by 1990. The corresponding value for overall imports of the South from the North (at 1978 prices) in 1990 would be approximately $490,000 million, with capital goods imports thereby accounting for almost 40 per cent of total imports of the South from the North. Since capital goods are far from homogeneous and the easiest steps in import substitution have already been taken, each additional step in the direction of import substitution is likely to increase the capital, skill, experience and research and development requirements. This would make it extremely unlikely that all imports of capital goods from the North could be substituted for by production in the South. Hence, this basis of measurement greatly overestimates the realistic potential for development of capital goods through South-South co-operation by the year 1990.

Table 2. Trade in capital goods and total trade of the North and the South in selected years
(Millions of dollars at current prices)

Region of origin and year	Region of destination: North		South		Total	
	Capital goods	Total trade	Capital goods	Total trade	Capital goods	Total trade
North						
1963	26 531	95 662	9 277	25 186	35 808	120 848
1967	42 997	139 301	12 735	33 721	55 732	173 022

continued

Table 2 (continued)

Region of origin and year	Region of destination: North — Capital goods	North — Total trade	South — Capital goods	South — Total trade	Total — Capital goods	Total — Total trade
1970	69 770	211 167	18 763	46 546	88 533	257 713
1975	168 312	511 283	66 792	150 496	235 104	661 779
1978	263 318	617 667	99 384	207 219	362 702	824 886
South						
1963	70	25 946	192	7 470	262	33 416
1967	252	33 137	339	9 060	591	42 197
1970	550	45 068	602	12 193	1 152	57 261
1975	2 760	167 794	3 072	51 684	5 832	219 478
1978	6 417	286 934	6 458	99 248	12 875	386 182
Total						
1963	26 601	121 608	9 469	32 656	36 070	154 264
1967	43 249	172 438	13 074	42 781	56 323	215 219
1970	70 320	256 235	19 365	58 739	89 685	314 974
1975	171 072	679 077	69 864	202 180	240 936	881 257
1978	269 735	904 601	105 842	306 467	375 577	1 211 068

Source: UNIDO, unpublished UNIDO-UNCTAD economic model data files, and United Nations Conference on Trade and Development, Handbook of International Trade and Development Statistics, Supplement 1980 (United Nations publication, Sales No. E/F.80.II.D.10).

As an alternative measure of potential development Yeats ([10], chapter 3) suggested the minimum of two values, on the one hand, the value of southern imports from the North, and on the other, the value of northern imports from the South. On the assumption that the South should consider exporting, even to the South, only those commodities which are labour-intensive, he also restricted his attention to sectors identified in previous studies as relatively labour-intensive. To identify the candidate subsectors and relevant magnitudes, he applied his suggested criterion to a list of labour-intensive manufacturing industries at the five-digit level the Standard International Trade Classification (SITC). The results for capital goods only are shown in table 3. By restricting the first measure of potential for increased South-South trade in two ways, namely, by focusing only on labour-intensive products and by limiting the magnitude to the amount exported by the South to the North, Yeats' measure is undoubtedly a very conservative and restrictive one. The aggregate total of potential South-South trade in capital goods estimated by this method is only $2,718 million (at 1975 prices), or 2 per cent of the total potential South-South trade in manufacturing sectors which he identified. Even after adjusting for the difference between 1975 and 1978 prices, this estimate is considerably less than 2 per cent of the total potential estimated above by the first (single-criterion) measure.

Whereas total imports of the South from the North, as a measure of potential for South-South trade, greatly overstates the realistic potential for growth in South-South trade and production, by limiting the estimated magnitude of such potential, in the first instance, to labour-intensive products and, in the second, to that which the South already

Table 3. Measure of potential South-South trade in capital goods based on 1975 prices
(Millions of dollars)

SITC	Commodity group	OECD country imports from developing countries in 1975	Developing country imports from OECD countries in 1975	Developing country exports diverted (percentage)	OECD country exports diverted (percentage)	Potent trade develc count
695	Hand tools	68	70	1.00	0.10	6
712	Agricultural machinery	18	2 137	1.00	0.01	1
714.2	Calculating machines	273	253	0.93	1.00	25
714.3	Statistical machines	88	484	1.00	0.18	8
714.9	Office machines	160	561	1.00	0.29	16
715.1	Metalworking machines	23	2 245	1.00	0.01	2
715.2	Other metalworking machines	2	679	1.00	0.00	
717.1	Textile machines	11	2 666	1.00	0.00	1
717.3	Sewing machines	31	267	1.00	0.12	3
718.1	Paper mill machines	3	450	1.00	0.01	
718.8	Food-processing machines	3	533	1.00	0.01	
719.2	Pumps	50	2 821	1.00	0.02	5
719.5	Power tools, n.e.s	16	982	1.00	0.02	1
719.6	Other non-electrical machines	15	949	1.00	0.02	1
719.8	Machinery, n.e.s.	24	2 762	1.00	0.01	2
719.91	Moulding boxes	3	149	1.00	0.02	
719.92	Taps and values	2	1 263	1.00	0.00	
722	Electric power machines	303	3 404	1.00	0.09	30
729.1	Batteries and accumulators	24	242	1.00	0.10	2
720.2	Electric lamps	66	128	1.00	0.51	6
729.3	Themionic valves	976	1 151	1.00	0.85	97
729.4	Automotive electrical equipment	31	319	1.00	0.10	3
729.9	Electrical machinery, n.e.s.	213	1 487	1.00	0.36	21
731	Railway vehicles	6	852	1.00	0.01	
732.8	Motor vehicle bodies	180	3 543	1.00	0.05	18
732.9	Motorcycles and parts	8	463	1.00	0.02	
861.2	Spectacles and frames	21	69	1.00	0.32	2
861.3	Optical goods	12	15	1.00	0.76	1
861.4	Photographic cameras	89	144	1.00	0.62	8
861.6	Photographic equipment	18	246	1.00	0.07	1
	Total	2 737	31 335			2 71
	Total projected increase					119 55
	Percentage of total	2	26			

Source: A.Y. Yeats, Trade and Development Policies (London, Macmillan,1981), pp. 48-51, table 3.6.

exports to the North and hence which could presumably be diverted to the South, Yeats' measure greatly understates such potential.

It has been noted that factor-intensity should not be such an important consideration in choosing the specific types of capital goods that should be produced and the magnitude of such production in the South for export to the South. Moreover, the fact that even when a certain factor which is intensively used in the production of a particular type of capital good is not available in a specific region of the South, generally it is available within the South as a whole. Hence it should be possible to achieve the necessary amount of factor accumulation, mobility and complementarity of production of capital goods if done on the basis of a comprehensive programme of co-operation within the South.

Referring back to table 1 above, it may be seen that the capital goods industries are relatively low in energy and physical capital-intensity but relatively high in human-capital-intensity. While some regions of the South, such as Tropical Africa, North Africa and the Middle East, may be extremely short in supplies of skilled labour and management, other regions and countries of the South, including Egypt and Lebanon, India, the Republic of Korea, other East Asian countries and the more developed countries of Latin America, have relatively plentiful supplies of such scarce factors of production, making South-South co-operation a desirable and even necessary vehicle for the successful development of capital goods industries. Finally, given the especially high shares of southern imports of capital goods from the North, as reflected in the last column of the table, it is clear that the quantitative potential for global import substitution through South-South co-operation is considerably greater in these industries than in any other.

As previously stated, labour-intensity and the ability to export to the North may be overly restrictive criteria for determining the potential for development of South-South co-operation. However, because of the importance of dynamic factors such as market creation and learning-by-doing in the development of capital goods industries, it seems appropriate to insist not only on a relatively low rate of new product development, but also on at least above-average growth rates in the South of both real value added and exports of capital goods.

Basic data on real value added in each capital goods subsector by region for various years between 1963 and 1979 are given in table 4. During that period the growth rates of the southern capital goods industry as a whole (8.9 per cent), the non-electrical machinery sector (10.7 per cent) and the electrical machinery sector (10.8 per cent) have been highly satisfactory (see table 5). Moreover, the growth rates are considerably larger than, on the one hand, those of the North and of the world as a whole in the capital goods industries, and, on the other, those of either the North or the South in all industries other than basic goods, the growth rate of which has been about equal to that of capital goods in the South. Above-average growth rates have also been observed in each of the three most important ISIC categories (382, 383 and 384) in the East Asia, Latin America and North Africa-Middle East regions. East Asia and South Asia have also enjoyed rapid growth in ISIC 385, and the North Africa-Middle East region has had above-average growth in the relatively heterogeneous ISIC 390. The omission of the North Africa-Middle East region from the above-average category of the other capital goods subsectors may be attributed to events in the Islamic Republic of Iran.

Tables 6 and 7 present the two-by-two (North-South) trade matrices for each two-digit SITC capital goods subsector for the years 1970, 1975

Table 4. Value added of capital goods and subsectors by region and year
(Millions of 1975 dollars)

Region and year	Non-electrical machinery (ISIC 382)	Electrical machinery (ISIC 383)	Transport equipment (ISIC 384)	Professional and scientific equipment (ISIC 385)	Other capital goods (ISIC 390)	Total
Latin America						
1963	1 176	1 477	2 084	172	437	5 346
1967	1 974	2 378	3 056	270	616	8 294
1970	2 496	3 238	4 463	328	765	11 290
1975	5 547	4 694	7 696	544	1 093	19 574
1977	5 932	5 443	7 737	577	1 090	20 779
1979	6 861	6 544	9 286	600	1 216	24 507
Tropical Africa						
1963	30	55	122	1	46	254
1967	44	75	133	1	66	319
1970	57	104	182	2	93	438
1975	82	142	271	3	154	652
1977	67	154	524	2	84	831
1979	67	176	206	2	80	531
North Africa -Middle East						
1963	76	74	80	2	16	248
1967	78	134	130	5	40	387
1970	106	207	230	4	46	593
1975	302	610	562	5	89	1 568
1977	387	699	668	5	103	1 862
1979	441	807	691	..	95	1 934
South Asia						
1963	316	281	722	31	668	2 018
1967	549	434	648	37	870	2 538
1970	716	662	615	49	582	2 624
1975	917	784	705	76	675	3 157
1977	1 083	918	780	91	825	3 697
1979	1 229	1 019	798	128	..	3 174
East Asia						
1963	104	206	324	31	182	847
1967	155	320	359	49	233	1 116
1970	193	531	468	63	228	1 483
1975	445	1 206	1 044	166	336	3 197
1977	592	2 193	1 254	288	461	4 788
1979	885	3 314	1 720	363	429	6 711
South						
1963	1 702	2 093	3 332	237	1 349	8 713
1967	2 800	3 341	4 326	362	1 825	12 654
1970	3 568	4 742	5 958	446	1 717	16 431
1975	7 293	7 438	10 281	794	2 357	28 163
1977	8 061	9 407	10 963	963	2 573	31 967
1979	9 483	11 860	12 601	1 093	1 831 a/	36 868
World						
1963	81 714	53 887	78 006	18 685	14 883	247 175
1967	108 415	75 195	100 601	26 543	19 213	329 967
1970	136 225	100 454	119 579	33 971	22 501	412 730
1975	166 521	128 898	150 666	47 543	28 878	522 500
1977	185 736	154 301	174 908	57 025	33 832	605 802
1979	209 721	177 728	191 230	65 865	36 314 a/	680 858

Source: UNIDO data base; information supplied by the Statistical Office of the United Nations with estimates by the UNIDO secretariat.

a/ Incomplete data.

by region of the South and the world
(Percentage)

Region and period	Non-electrical machinery (ISIC 382)	Electrical machinery (ISIC 383))	Transport equipment (ISIC 384)	Professional and scientific equipment (ISIC 390)	Other capital goods (ISIC 390)	Total capital goods
Latin America						
1963-1979	12.48	10.43	10.47	8.69	7.06	10.68
1970-1977	15.52	9.04	9.60	9.87	6.08	10.70
Tropical Africa						
1963-1979	5.50	8.06	3.55	4.73	3.76	5.04
1970-1977	2.73	6.76	19.27	0.0	-1.68	11.26
North Africa -Middle East						
1963-1979	12.44	17.27	14.26	--	12.61	14.67
1970-1977	24.09	22.49	19.45	3.79	14.38	21.01
South Asia						
1963-1979	9.48	8.97	0.67	9.91	-	3.07
1970-1077	7.14	5.60	4.04	10.87	5.99	5.88
East Asia						
1963-1979	15.34	20.35	11.77	17.82	5.88	14.80
1970-1977	20.54	26.67	17.85	28.83	12.45	21.57
South						
1963-1979	10.7	10.8	8.2	9.4	1.8	8.9
1970-1977	10.7	8.9	7.9	10.1	5.2	8.7
World						
1963-1979	6.49	8.28	6.16	8.76	6.13	6.99
1970-1977	5.30	7.12	6.54	9.02	7.03	6.60

Source: UNIDO data base; information supplied by the Statistical Office of the United Nations with estimates by the UNIDO secretariat.

Table 6. Two-by-two trade matrices for capital goods subsectors in selected years at current prices
(Millions of dollars)

Origin	1970 destination			1975 destination			1977 destination		
	North	South	World	North	South	World	North	South	World
Non electrical machinery (SITC 71)									
North	28 152	8 643	36 795	73 736	29 965	103 700	88 831	38 065	126 896
South	208	324	532	1 209	1 485	2 693	2 560	2 066	4 627
World	28 360	8 967	37 327	74 945	31 449	106 394	91 391	40 132	131 523
Electrical machinery (SITC 72)									
North	13 188	3 971	17 159	33 295	13 312	46 607	45 211	21 088	66 299
South	598	206	884	3 057	1 267	4 324	5 419	2 324	7 743
World	13 786	4 177	17 963	36 352	14 579	50 931	50 630	23 412	74 042
Transport equipment (SITC 73)									
North	25 967	7 298	33 264	63 924	29 924	93 848	89 206	35 869	125 075
South	134	230	364	771	1 855	2 626	1 179	2 923	4 102
World	26 101	7 527	33 628	64 695	31 779	96 474	90 384	38 792	129 177
Scientific and professional equipment (SITC 86)									
North	4 817	1 211	6 028	11 903	3 139	15 043	15 851	4 544	20 395
South	89	71	160	624	352	976	1 072	646	1 718
World	4 906	1 282	6 188	12 527	3 491	16 019	16 924	5 189	22 113

Source: United Nations Statistical Office, with estimates by the UNIDO secretariat.

Note: Commodity class based on the Standard International Trade Classification (SITC), Revision 1.

Table 7. Two-by-two trade matrices for capital goods and subsectors in selected years at 1975 prices
(Millions of dollars)

Origin	1970 destination			1977 destination		
	North	South	World	North	South	World
			Non-electrical machinery (SITC 71)			
North	44 686	13 719	58 405	79 313	33 987	113 300
South	347	540	887	1 954	1 577	3 522
World	45 033	14 259	59 292	81 267	35 564	116 832
			Electrical machinery (SITC 72)			
North	20 933	6 303	27 237	40 367	18 829	59 196
South	997	343	1 340	4 137	1 774	5 911
World	21 930	6 646	28 577	44 504	20 603	65 107
			Transport equipment (SITC 73)			
North	41 217	11 584	52 800	79 648	32 026	11 674
South	223	383	607	900	2 231	3 131
World	41 440	11 967	53 407	80 548	34 257	114 805
			Scientific and professional equipment (SITC 86)			
North	7 646	1 922	9 568	14 153	4 057	18 210
South	148	118	267	818	493	1 311
World	7 794	2 040	9 835	14 971	4 550	19 521

Source: United Nations Statistical Office, with estimates from the UNIDO secretariat.

a/ Commodity class based on the Standard International Trade Classification, Revision 1.

and 1977. Table 6 presents the trade flows in current prices, while table 7 contains corresponding information based on data at constant 1975 prices. The figures given for the South in these tables show a consistent rise over time. Indeed, from the growth rates in real terms computed from table 7 for the period 1970-1977 and which are presented in table 8, it may be seen that exports in all capital goods sectors from the North, from the world as a whole and especially from the South have been growing very rapidly. Capital goods exports by the South as a whole have been growing at almost 20 per cent per annum and those of electrical machinery and transport and scientific equipment have been growing at over 20 per cent per annum.

The above-average growth rates of southern production and exports of capital goods in general, and of the three more promising subsectors thereof in particular, namely, non-electrical machinery (ISIC 382), electrical machinery (ISIC 383) and transport equipment (ISIC 384), imply that the shares of the South in production and exports of these increasingly important commodity sectors must be rising. The validity of such an implication is confirmed by the data presented in table 9.

Part A of table 9 shows that the shares of developing countries in world value added of non-electrical machinery, electrical machinery and transport equipment have shown impressive increases, especially during the 1970s. The shares of the South in world exports of capital goods, as reflected in part B of table 9, show similar gains, and in part C it may be seen that the proportion of southern capital goods imports from the South also increased sharply between 1970 and 1977. Finally, part D shows that the shares of capital goods exports by the different southern regions to other southern regions has generally remained high - above 40 per cent overall - and is particularly high in non-electrical machinery and transport equipment. While the corresponding share is relatively low in the electrical machinery subsector, it has been rising over time so that by 1977 it was 30 per cent.*

Table 8. Real growth rates of capital goods exports of the North, the South and the world during the period 1970-1977
(Percentage)

Origin	Destination		
	North	South	World
	Non-electrical machinery (SITC 71)		
North	7.44	12.01	8.64
South	24.12	14.34	18.85
World	7.66	12.10	8.85

continued

*The real growth in South-South trade may be somewhat overestimated from this data since it includes intra-firm sales and transfers from one country to another which are sometimes thought to be quite important. Unfortunately, the data required for distinguishing such flows from true South-South flows is not available.

Table 8 (continued)

Origin	Destination		
	North	South	World
	Electrical machinery (SITC 72)		
North	8.55	14.66	10.19
South	19.47	22.80	20.38
World	9.25	15.19	10.84
	Transport equipment (SITC 73)		
North	8.58	13.55	25.96
South	19.05	24.64	22.75
World	8.66	14.05	10.04
	Scientific and professional equipment (SITC 86)		
North	8.00	9.79	8.38
South	23.83	19.57	22.01
World	8.50	10.55	8.95
	All capital goods a/		
North	7.99	12.67	8.88
South	19.61	11.98	17.79
World	8.17	13.06	6.13

Source: United Nations Statistical Office, with estimates from the UNIDO secretariat.

a/ Growth rates are for the period 1970-1978.

Table 9. Shares of the South in world value added, exports and imports of capital goods
(Percentage)

Year	Non-electrical machinery	Electrical machinery	Transport equipment	Scientific instruments	Other machinery	Total
	A. Shares in world value added					
	(ISIC 382)	(ISIC 383)	(ISIC 384)	(ISIC 385)	(ISIC 390)	
1963	2.08	3.88	4.27	1.27	9.06	3.53
1967	2.58	4.44	4.30	1.36	9.50	3.83
1970	2.62	4.72	4.98	1.31	7.63	3.98
1975	4.38	5.77	6.82	1.67	8.16	5.39
1977	4.34	6.10	6.27	1.69	7.61	5.28
1979	4.52	6.67	6.59	1.66	5.04	5.41

continued

Table 9 (continued)

Year	Non-electrical machinery	Electrical machinery	Transport equipment	Scientific instruments	Other machinery	Total
			B. Shares in world exports			
	(SITC 71)	(SITC 72)	(SITC 73)	(SITC 86)		
1970	1.40	4.50	1.10	1.6	..	2.00
1975	1.60	8.4	4.1	5.80	..	2.71
1977	3.50	10.50	3.20	7.80	..	3.32
1978	..	..	..	..	..	3.43
			C. Shares in southern imports			
	(SITC 71)	(SITC 72)	(SITC 73)	(SITC 86)		
1970	3.60	4.90	3.00	5.50	..	3.50
1975	4.70	8.70	2.4	13.0	..	4.74
1977	5.10	9.90	7.50	12.40	..	6.40
1978	..	..	..	..	..	6.53
			D. Shares in southern exports			
	(SITC 71)	(SITC 72)	(SITC 73)	(SITC 86)		
1970	60.9	25.6	63.2	44.4	..	44.7
1975	55.1	29.3	41.6	36.1	..	43.8
1977	44.7	30.0	71.3	37.6	..	43.8

Source: UNIDO data base, information supplied by the Statistical Office of the United Nations with estimates by the UNIDO secretariat.

While developing countries have enjoyed impressive growth rates of capital goods production and exports and corresponding increases in their shares of world output and trade over the last decade or two, it would be misleading to suppose that these gains have been spread evenly throughout the South. Indeed, quite the opposite is the case. Southern capital goods production and exports have been and remain highly concentrated, as reflected in table 10.

With regard to regional shares in southern value added of capital goods, table 10 shows that approximately two thirds of the 1979 total was provided by Latin America, whereas the corresponding proportion contributed by the Tropical Africa and North Africa-Middle East regions combined was less than 7 per cent. The only significant changes in the value-added shares have been the sharp decline in that of South Asia and the equally sharp rise in that of East Asia during the period 1970-1979.

In the regional shares of the various subsectors of southern capital goods production, moderate deviations from the overall pattern may be seen in table 10 from one subsector to another. For example, in the electrical machinery subsector the Latin American share in southern value added has been falling slightly and the corresponding rise in the East Asian share has been especially great from 1970 to 1980. On the other hand, the Latin

Table 10. Shares of the different developing regions in the value added and exports of capital goods of the South (Percentage)

ion and year	Non-electrical machinery		Electrical machinery		Transport equipment		Total	
	Value added (ISIC 382)	Exports (SITC 71)	Value added (ISIC 383)	Expprts (SITC 72)	Value added (ISIC 384)	Export (SITC 73)	Value added	Exports
in America								
963	69		71		63		61	
970	70	39	68	21	75	26	70	31
975	76	36	63	23	75	30	70	30
977	74	28	58	18	71	29	65	25
979	72		55		74		66	
ical Africa								
963	2		3		4		3	
970	2	3	2	1	3	10	3	4
975	1	2	2	1	3	7	2	2
977	1	1	2	1	5	2	3	0.5
979	1		1		2		1	
th Africa								
ddle East								
963	4		4		2		3	
970	3	8	4	2	4	10	4	9
975	4	11	8	4	5	26	6	7
977	5	9	7	5	6	20	6	6
979	5		7		5		5	
th Asia								
963	19		13		22		23	
970	20	8	14	3	10	12	16	10
975	13	6	11	2	7	4	11	6
977	13	4	10	2	7	6	12	5
979	13		9		6		9	
t Asia								
963	6		10		10		10	
970	5	23	11	43	8	24	8	40
975	6	28	16	47	10	19	11	53
977	7	20	23	51	11	30	15	60
979	9		28		14		18	
trally nned Asia a/								
970	..	5	..	2	..	7	..	..
975	..	4	..	2	..	6	..	..
977	..	3	..	2	..	2	..	..

Sources: Value added computed from data in table 5 of this paper. Trade computed from data vided by the United Nations Statistical Office with estimates by UNIDO secretariat.

a/ Value added and share of total exports of centrally planned Asia not available.

American shares have been particularly buoyant and the corresponding increases in the East Asian shares have been considerably smaller in the case of the non-electrical machinery and transport equipment subsectors.

With respect to export shares, the dominance of Latin America is considerably diminished and generally declining, but this is offset by a much larger and rising share of East Asia. The difference between the regional production and export shares is indicative of the striking difference in the degree of outward orientation between Latin America (low) and East Asia (high).

Indeed, the degree of concentration in production and trade is sufficiently great that it is not entirely meaningful to describe the experience and performance in terms of regions. According to the United Nations Industrial Development Organization, more than 60 per cent of the southern exports of capital goods was provided by only five developing countries and more than 85 per cent by 10 countries [33]. Moreover, since country data is somewhat easier to bring up to date than regional data, it is useful to supplement our analysis of regions with more recent capital goods export data pertaining to some of the more important capital-goods-exporting countries. This is done in tables 11 and 12. The former includes data for 1980, while the latter contains data for 1975 and 1978.

The data presented in table 11 confirm the extremely rapid growth in southern exports of capital goods during the 1970s. The value of exports of capital goods evaluated in United States dollars at current prices in the countries included in the table increased almost tenfold during that period. The growth rates of capital goods exports of Brazil, Colombia, Malaysia, the Republic of Korea and Singapore all exceeded that of the sample as a whole, while those of Argentina, Hong Kong, India, Ivory Coast, Mexico, Trinidad and Tobago and Yugoslavia* lagged somewhat behind the overall average of the sample. In no case, however, did the value of such exports rise by less than 95 per cent during the decade. The growth rates of capital goods exports of the countries and territories included in the table exceeded the growth rates of their total exports during the period 1975-1980 by considerably more than during the 1970-1975 period, reflecting the rapidly rising relative importance of southern capital goods exports.

As to the direction of southern exports of capital goods, table 12 shows that there are two rather distinct patterns. The dominant pattern, exemplified especially by the countries of Latin America and South Asia, is that of heavy concentration on exports to the South. This proportion is 60 per cent or more for capital goods as a whole in Brazil, Colombia and India. The other and more recent pattern is that displayed primarily by East Asian producers, such as Hong Kong, the Republic of Korea and Singapore, and also to a lesser extent by Mexico, well over half of whose capital goods exports go to the North. In the latter case, subcontracting, often co-ordinated by transnational corporations, plays an important role in such exports. Moreover, the degree of specialization of individual countries in different product lines and segments of the markets for capital goods is sufficiently great that the proportion of exports directed to the South by any given southern exporter may also vary

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*Yugoslavia is not always classified as a developing country. In this study it is normally grouped with Western Europe.

Table 11. Value and growth of capital goods exports of developing countries in selected years

Exporting countries and territories	Value of capital goods exported (millions of dollars)			Average annual rate of export growth (percentage)				Share of capital goods in total exports (percentage)	
				Capital goods		Total exports			
	1970	1975	1980	1970-1975	1975-1980	1970-1975	1975-1980	1970	1980
Argentina	69.7	422.6	504.8	43.4	9.3	10.8	38.0	3.9	8.9 a/
Brazil	63.3 b/	921.6	3 496.7	56.3	30.6	24.7	18.4	2.7	17.4
Colombia	6.3	35.7	70.1 a/	41.5	40.1	15.1	29.1	0.9	2.9 a/
Hong Kong	244.6	683.8	1 792.4	22.8	21.2	17.8	24.3	12.0	13.1
India	84.0 b/	356.0	452.9 a/	27.2	12.8	15.6	17.2	4.6 b/	7.6 a/
Indonesia	3.6	22.8	40.5 c/	56.6	3.7	46.5	25.2	0.3	0.2 c/
Iran, Islamic Republic of	2.1 b/	43.3	-	65.6	-	43.3	-	0.0 b/	-
Ivory Coast	8.4	26.0 d/	56.5 c/	32.6	16.8	26.9	15.6	1.8	2.2 c/
Kuwait	22.2	111.9 d/	286.6 a/	49.8	288.9	54.9	11.0	1.2	2.9 a/
Malaysia	29.5	246.1	417.7 a/	93.4	30.3	17.9	25.7	1.7	6.9 a/
Mexico	132.5	287.3	263.6 a/	16.7	-4.2	19.9	13.9	11.0	6.3 a/
Pakistan	3.4	7.0	35.6	15.5	38.4	8.2	20.0	0.4	1.4
Republic of Korea	60.8	712.2	2 080.9	63.6	23.9	43.9	28.0	7.3	11.9
Singapore	181.6	1 374.7	2 765.4	49.9	33.2	28.2	29.2	11.7	14.3
Thailand	0.5 b/	21.7 d/	176.8 c/	256.6	52.1	52.9	16.5	0.0 b/	3.4 c/
Trinidad and Tobago	6.5	14.2	32.9 d/	16.9	5.8	29.8	10.2	1.3	0.7 c/
Yugoslavia	404.7	1 427.5	2 943.3 c/	28.7	19.8	19.4	19.0	24.1	30.3 c/
TOTAL	1 591.0	5 725.4	15 401.6	29.2	21.9	30.4	10.7	6.9	10.7

Source: Computed from United Nations Commodity Trade Statistics (various issues).

a/ = 1977.
b/ = 1969.
c/ = 1979.
d/ = 1978.

Table 12. Capital goods exports
type
(Millions

SITC	Commodity group	Brazil				Colombia				Hong Kong		
		Export value		Southern share		Export value		Southern share		Export value		Southe
		1975	1978	1975	1978	1975	1978	1978	1975	1978	1975	1978
7	Machinery and transport equipment	896.2	1 939.3	65.2	58.7	32.2	65.5	86.6	84.8	672.1	1 330.2	17.9
71	Non-electrical machinery	425.8	845.5	59.9	52.7	18.5	33.5	93.5	94	98.2	292.2	26.3
72	Electrical machinery	171.8	346.5	47.6	33.3	6.7	11.2	97	91.1	562.2	1 026.4	15.5
73	Tranport equipment	298.6	747.4	82.9	77.1	7.1	21.1	57.7	65.4	11.7	11.4	59
711.4	Aircraft engines	18.2	77.2	24.7	23.6	--	0.1	--	--	--	--	--
711.5	Other internal combustion engines	91.1	219.3	23.9	14.6	0.7	2.2	100	100	--	8.9	--
712	Agricultural machinery	33.2	98.4	97.0	77.5	1.5	3.4	93.3	100	--	--	--
714	Office machinery	109.3	129.2	45.7	50	1.4	1.2	100	100	70.8	237.1	5.1
715	Metalworking machinery	15.4	21.3	96.1	85.4	1.6	1.9	100	100	3.3	4.4	97
717	Textile and leather machinery	23	35.3	67.8	65.4	1.6	2.7	100	92.6	6.7	6.8	91
718	Special industrial machinery	46.8	85.7	88.7	95.1	1.4	3.9	64.3	92.3	0.9	1.3	77.8
719	Machinery other than electrical	83.7	177.3	83.4	78.5	9.5	15	94.7	92	16.5	33.8	62.4
722	Electric power machinery	34	48.1	78.2	63.4	1.7	4.4	100	95.5	6.6	38.6	25.8
723	Equipment for distributing electricity	5.2	7.4	57.7	74.3	1.1	3.2	100	78.1	1.7	4.7	82.4
724	Telecommunications apparatus	63.7	131.6	21.2	15.8	0.5	0.1	100	100	299.5	552	17.1
725	Domestic electrical equipment	14.3	22.8	93.7	96.9	2.2	2.4	100	100	56.6	166.8	23.7
726	Medical apparatus	0.2	0.5	100	100	--	--	--	--	--	--	--
729	Electrical machinery, other	54.5	136	45.5	26.8	1.2	1.1	91.7	100	197.8	264.3	9.9
731	Railway vehicles	5.7	25.2	96.5	86.5	--	--	--	--	--	--	--
732	Road motor vehicles	272.1	551.6	82.9	78.9	5.6	14.5	48.2	57.2	0.3	0.2	0
733	Road vehicles other than motor	6.6	19.9	87.9	91.5	0.3	5	100	100	0.8	1.4	0
734	Aircraft	10.3	35.9	75.7	49.3	0.8	1.3	100	23.1	--	--	--
735	Ships and boats	3.9	114.8	71.8	72.4	0.3	0.2	100	100	10.5	10	65.1

Source: United Nations Bulletin of Statistics on World Trade in Engineering Products, issues for 1975, 1976, 1978 and 1979.

elected southern exporters by
estination
ollars f.o.b.)

India			Mexico				Republic of Korea				Singapore			
value	Southern share		Export value		Southern share		Export value		Southern share		Export value		Southern share	
1978	1975	1978	1975	1978	1978	1975	1978	1975	1978	1975	1975	1978	1975	1978
458.2	76.3	77.5	285.4	611.3	33.2	32	700.7	2 570	24	31	1 220	2 519.7	44.8	44.2
195.4	77.2	76.6	109	242.3	43.7	31.6	76.3	201.3	15.9	36.9	375	572.9	51.5	60.5
108.7	66.4	67.3	43.8	87.1	57.8	69.6	440.9	1 247.6	12.5	18.5	620.4	1 568.4	61.1	32.3
154	82.6	85.8	132.6	130.2	16.5	20.6	183.6	1 121.1	55.1	44	224.6	378.4	59.3	68.7
0.3	--	33.3	--	--	--	--	0.2	3.4	50	14.7	33.3	28.5	3.6	13
43	41.3	62.1	32.7	113.3	30.3	20.7	2	7.4	80	68.9	20.0	50.2	84	78.1
5.8	94.7	87.9	2.8	6.1	42.9	67.2	0.8	2.3	12.5	60.9	4.2	4.3	90.5	90.7
1.9	29	68.4	19.1	30.8	82.2	81.2	44.1	69.6	1.6	5.7	87.5	82.7	15.4	16.3
16.3	38.1	53.4	--	1.1	--	81.8	0.9	3.9	22.2	43.6	6.9	20.1	71	42.8
15.3	94.9	83.7	3.8	2.7	63.2	51.9	10.5	26.9	16.2	39.8	8.1	13.4	92.6	85.8
22.5	98	94.7	2.3	10.1	52.2	41.6	3.7	24.9	73	89.6	96.4	121.7	64.4	86.2
66.6	77.8	75.7	47.7	61.3	38.4	28.2	13.8	49.3	24.6	54.2	113.2	246	69.1	63.9
39.1	90.9	94.4	10.7	13.4	25.2	64.9	40.4	80.8	12.9	21	54.1	115.4	36.6	36.9
21.2	28.9	44.8	5.1	9.7	76.5	36.1	16.9	45.8	81.7	91.7	5.1	11.1	92.2	90.1
7.9	70.1	43	18.8	5	68.1	46	138	611.5	5.6	10.5	168.8	468.1	17.7	28.9
11.4	91.8	86	1	5.1	90	49	3.2	21.8	0	33.5	14.7	50.9	46.9	44.2
0.4	60	75	--	0.1	--	0	0.2	1.1	0	0	2.8	2.8	7.1	28.6
28.7	45	44.9	8.3	53.8	59	81.2	242.2	486.6	11.6	20.7	374.8	920.1	42.3	35.4
5.2	55.3	90.4	0.3	11.4	0	0.9	20.5	89.9	13.2	11.1	0.3	0.5	100	80
100.8	88.1	92.2	115.1	256.2	17.2	20.4	3.4	79.4	44.1	77.5	80.4	145.3	94.4	92.6
37.7	93.6	86.2	1.8	2.1	5.6	33.3	7.7	18.3	6.5	6	3	8.6	56.7	45.3
0.1	0	0	12.9	7.5	1.6	6.7	14.3	133.3	0.7	2.7	10.7	42.9	76.6	56.6
10.2	96.3	18.6	2.5	4.7	64	100	137.8	800.2	69.9	51.1	130.2	181	36.2	53.2

considerably from one type of capital goods to another (Amsden [27], Mitra [15]). Table 12 also serves to identify some of the more dynamic types of capital goods within the main capital goods subsectors. For example, even between 1975 and 1978 the export values (in current prices) of engines (SITC 711) virtually tripled and those of agricultural machinery (SITC 712) doubled in all countries except India and Singapore. Other categories with particularly impressive export performances were special industrial machinery (SITC 718), other special machinery (SITC 719), electric power machinery (SITC 722), telecommunications apparatus (SITC 724), other electrical machinery (SITC 729), road motor vehicles (SITC 733) and ships and boats (SITC 735).*

Table 13 provides even more concrete evidence of the rising shares of the South in world trade in capital goods and the extremely high growth rates of capital goods exports (in current prices) between 1967 and 1977, as reflected by the rise in the southern share of world exports of other electrical machinery (SITC 729) from 2.25 per cent in 1967 to 8.80 per cent in 1977. Likewise, its shares of world exports of engines (SITC 711), electric power machinery (SITC 722), ships and boats (SITC 735), textile and leather machinery (SITC 717), agricultural machinery (SITC 712), road vehicles (non-motor) (SITC 733) and railway vehicles (SITC 731) all more than tripled over the same period.

Table 14 relates the export growth performance of the South as a whole at the three-digit SITC level to that of both the North and the world and distinguishes also by destination of such exports. The column for the world shows that the average annual growth rates of the South exceeded 10 per cent in real terms in all sectors of capital goods other than textile and leather machinery, in which the growth rate was a healthy 7.50 per cent per annum despite the fact that world exports were declining. In most sectors southern exports were growing two to three times faster than northern exports. Southern exports to the South were growing slower than those to the North in power-generating machinery, agricultural machinery, office machines, metalworking machinery, textile and leather machinery, other machinery (SITC 719), domestic electrical equipment, railway vehicles and non-motor road vehicles, but more rapidly than those to the North in machines for special industries (SITC 718), electric power machinery and switchgear, equipment for distributing electricity, telecommunications apparatus, other electrical machinery, road motor vehicles, aircraft and ships and boats.

An inevitable consequence of the rapid growth of capital goods production in most regions of the South has been a considerable amount of structural change. Tables 15 and 16 return to a higher level of subsector aggregation but clearly demonstrate the remarkable extent to which the shares of all capital goods have been increasing in manufacturing value added and employment in the South as a whole and in all regions of the South except South Asia and Tropical Africa, presumably because of the very slow rates of overall growth and the relatively low investment shares in those two regions.

Table 15 reveals some interesting patterns with respect to the shares of the different capital goods sectors in overall manufacturing value

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*Some of these three-digit categories are not officially treated as capital goods although items within each such category are.

Table 13. Export values and growth rates of capital goods of developing countries and territories in selected years

SITC	Commodity group	1967 Value (thousands of dollars)	1967 Percentage of group total	1967 Percentage of world	1970 Value (thousands of dollars)	1970 Percentage of group total	1970 Percentage of world	1973 Value (thousands of dollars)	1973 Percentage of group total	1973 Percentage of world	1975 Value (thousands of dollars)	1975 Percentage of group total	1975 Percentage of world	1977 Value (thousands of dollars)	1977 Percentage of group total	1977 Percentage of world	1970-1977 growth rate (percentage)
729	Electrical machinery, other	72 101	0.19	2.25	232 178	0.21	4.09	760 774	0.78	6.94	1 051 297	0.50	6.96	1 952 335	0.68	8.80	35.6
732	Road motor vehicles	67 172	0.18	9.55	157 797	0.14	0.72	452 316	0.47	1.11	945 455	0.45	1.63	1 149 530	0.40	1.41	33.1
719	Machinery other than electrical	50 450	0.13	0.56	131 564	0.12	0.92	362 976	0.37	1.43	539 223	0.26	1.31	724 214	0.25	1.45	27.9
714	Office machinery	30 011	0.08	1.31	77 328	0.07	1.77	330 297	0.34	4.38	432 725	0.20	4.54	414 368	0.14	2.88	27.1
861	Scientific instruments	16 487	0.04	0.75	36 435	0.03	1.07	183 268	0.19	2.99	342 492	0.16	3.90	408 492	0.14	3.44	41.4
711	Non-electrical power machinery	25 222	0.07	0.62	66 747	0.06	1.15	154 836	0.16	1.81	412 357	0.20	3.12	492 417	0.17	2.86	33.7
722	Electric power machinery	20 769	0.05	0.88	56 158	0.05	1.57	145 100	0.15	2.10	313 181	0.15	2.96	559 988	0.20	3.49	39.1
718	Special industrial machinery	58 286	0.15	1.83	61 481	0.06	1.22	128 833	0.13	1.54	275 759	0.13	1.82	330 559	0.12	1.82	27.4
734	Aircraft	55 557	0.15	2.16	42 493	0.04	1.02	127 911	0.13	1.90	155 657	0.07	1.65	154 126	0.05	1.53	0.9
735	Ships and boats	35 660	0.09	1.22	34 609	0.03	0.81	110 229	0.11	1.09	351 821	0.17	2.15	886 682	0.31	4.30	58.9
717	Textile, leather machinery	10 750	0.03	0.52	26 062	0.02	0.85	54 607	0.06	0.98	96 681	0.05	1.43	105 674	0.04	1.57	22.1
695	Tools	11 984	0.03	1.56	23 191	0.02	1.97	50 741	0.05	2.56	99 361	0.05	3.35	146 853	0.05	3.80	30.4
712	Agricultural machinery	7 768	0.02	0.35	13 055	0.01	0.48	42 376	0.04	0.85	108 192	0.05	1.17	131 522	0.05	1.37	39.1
723	Electrical distribution machinery	6 504	0.02	1.07	20 095	0.02	2.03	39 612	0.04	2.63	92 464	0.04	3.40	107 318	0.04	2.87	27.8
733	Road vehicles, non-motor	4 167	0.01	1.06	12 938	0.01	2.14	37 840	0.04	2.36	80 530	0.04	3.85	119 426	0.04	4.09	37.2
715	Metalworking machinery	8 528	0.02	0.42	14 738	0.01	0.48	22 974	0.02	0.44	54 970	0.03	0.69	70 025	0.02	0.80	25.3
731	Railway vehicles	1 831	0.00	0.25	6 709	0.01	0.77	20 997	0.02	1.15	66 211	0.03	2.27	118 726	0.04	3.83	50.8
726	Medical apparatus	395	0.00	0.20	929	0.00	0.28	4 820	0.00	0.73	5 233	0.00	0.45				

Source: Handbook of International Trade and Development Statistics, 1977, 1979, 1980; UNCTAD secretariat computations based on United Nations Statistical Office data.

Notes: Export values calculated free on board.
Group totals given for developing countries.

Table 14. Average annual growth rates of capital goods at constant 1975 prices for the period 1970-1977
(Percentage)

Origin	Destination		
	North	South	World
Power generating machinery (SITC 711)			
North	5.65	9.51	6.76
South	19.09	10.36	15.61
World	5.97	9.54	7.01
Agricultural machinery and implements (SITC 712)			
North	9.19	4.19	7.95
South	21.23	15.65	16.72
World	9.22	4.56	8.04
Office machines (SITC 714)			
North	4.21	3.77	4.16
South	10.98	10.81	10.96
World	4.43	4.47	4.43
Metalworking machinery (SITC 715)			
North	1.93	10.28	3.69
South	24.03	14.11	17.05
World	2.03	10.42	3.86
Textile and leather machinery (SITC 717)			
North	-.84	2.57	-.24
South	20.80	4.46	7.50
World	0.67	2.69	-.43
Machines for special industries (SITC 718)			
North	4.61	9.96	6.43
South	15.73	17.12	16.86
World	4.67	10.31	6.64
Machinery and appliances and parts (n.e.s.) (SITC 719)			
North	5.11	11.62	7.06
South	31.95	17.98	24.78
World	5.54	11.83	43.28
Electric power machinery and switchgear (SITC 722)			
North	4.91	13.97	8.02
South	22.61	29.68	25.07
World	5.58	14.58	8.66
Equipment for distributing electricity (SITC 723)			
North	2.34	11.39	6.32
South	15.50	21.02	18.28
World	3.01	11.99	6.98

continued

Table 14 (continued)

Origin	Destination		
	North	South	World
Telecommunications apparatus (SITC 724)			
North	5.73	10.78	7.43
South	16.79	21.03	17.58
World	7.05	11.40	8.45
Domestic electrical equipment (SITC 725)			
North	5.82	11.07	6.75
South	32.55	18.62	23.35
World	6.29	12.06	7.40
Electrical apparatus for medical purposes (SITC 726)			
North	11.72	10.16	11.27
South	42.33	9.05	31.61
World	11.88	10.18	11.39
Other electrical machinery (SITC 729)			
North	5.37	11.69	6.77
South	17.71	19.97	18.27
World	6.44	12.51	7.80
Railway vehicles (SITC 731)			
North	7.98	7.91	7.96
South	15.72	13.25	14.39
World	8.14	8.09	8.14
Road motor vehicles (SITC 732)			
North	7.08	10.31	4.67
South	17.99	23.39	22.12
World	7.12	10.98	7.85
Road vehicles other than motor (SITC 733)			
North	9.11	15.34	10.62
South	33.76	16.90	21.05
World	9.56	17.20	11.13
Aircraft (SITC 734)			
North	-1.99	8.04	1.85
South	11.61	12.28	11.76
World	-1.73	8.07	2.00
Ships and boats (SITC 735)			
North	7.98	13.23	10.48
South	17.24	32.76	24.52
World	8.31	13.94	11.00

Source: UNIDO data base; information supplied by the Statistical Office of the United Nations with estimates by the UNIDO secretariat.

Table 15. Shares of capital goods value added in total manufacturing value added by region
(Percentages based on 1975 prices and exchange rates)

Region and year	Non-electrical machinery (ISIC 382)	Electrical machinery (ISIC 383)	Transport equipment (ISIC 384)	Scientific and professional equipment (ISIC 385)	Other machinery (ISIC 390)	Total capital goods
Latin America						
1963	2.76	3.47	4.89	0.40	1.03	12.56
1967	3.63	4.37	5.62	0.50	1.13	15.26
1970	3.69	4.79	6.60	0.49	1.13	16.70
1975	6.06	5.12	8.40	0.59	1.19	21.37
1977	5.96	5.47	7.77	0.58	1.10	20.88
1979	6.15	5.87	8.33	0.54	1.09	21.98
Tropical Africa						
1963	0.82	1.50	3.33	0.03	1.26	6.93
1967	0.91	1.55	2.75	0.02	1.36	6.59
1970	0.92	1.67	2.92	0.03	1.49	7.03
1975	1.04	1.80	3.44	0.04	1.95	8.27
1977	0.77	1.77	6.01	0.02	0.96	9.53
1979	0.77	2.02	2.36	0.02	0.92	6.09
North Africa -Middle East						
1963	0.84	0.82	0.89	0.02	0.18	2.74
1967	0.71	1.22	1.18	0.05	0.36	3.51
1970	0.78	1.52	1.69	0.03	0.34	4.36
1975	1.55	3.13	2.89	0.03	0.46	8.06
1977	1.74	3.14	3.00	0.02	0.46	8.36
1979	1.98	3.63	2.66	0.0	0.43	8.70
South Asia						
1963	2.90	2.58	6.63	0.28	6.13	18.52
1967	4.18	3.31	4.94	0.28	6.63	19.33
1970	4.96	4.59	4.26	0.34	4.03	18.19
1975	5.82	4.97	4.47	0.48	4.28	20.03
1977	6.26	5.30	4.51	0.53	4.77	21.36
1979	6.92	5.74	4.50	0.72	--	17.88 a/
East Asia						
1963	1.40	2.78	4.37	0.42	2.45	11.42
1967	1.64	3.38	3.79	0.52	2.46	11.78
1970	1.55	4.27	3.76	0.51	1.83	11.91
1975	2.18	5.90	5.10	0.81	1.64	15.63
1977	2.17	8.04	4.60	1.06	1.69	17.56
1979	2.57	9.61	4.99	1.05	1.24	19.47
South						
1963	2.31	2.84	4.52	0.32	1.83	11.81
1967	3.01	3.59	4.65	0.39	1.96	13.60
1970	3.11	4.14	5.20	0.39	1.50	14.34
1975	4.69	4.78	6.61	0.51	1.52	18.11
1977	4.60	5.36	6.25	0.55	1.47	18.22
1979	4.86	6.08	6.46	0.56	0.94	18.90
World						
1963	9.43	6.22	9.00	2.16	1.72	28.51
1967	9.86	6.84	9.15	2.41	1.75	30.00
1970	10.17	7.50	8.93	2.54	1.68	30.81
1975	10.37	8.03	9.38	2.96	1.80	32.55
1977	10.21	8.48	9.62	3.14	1.86	33.31
1979	10.50	8.90	9.57	3.30	1.82	34.09
	Southern share in total world manufacturing value added					
1963	0.19	0.24	0.38	0.03	0.16	1.00
1967	0.25	0.30	0.39	0.03	0.17	1.15
1970	0.27	0.35	0.44	0.03	0.13	1.23
1975	0.45	0.46	0.64	0.05	0.15	1.75
1977	0.44	0.52	0.60	0.05	0.14	1.76
1979	0.47	0.59	0.63	0.05	0.13	1.85

Source: UNIDO data base; information supplied by the Statistical Office of the United Nations with estimates by the UNIDO secretariat.

Note: Totals may not add precisely because of rounding.

a/ Does not include ISIC 390.

Table 16. Share of employment in capital goods in total manufacturing employment by region

gion d year	Non-electrical machinery (ISIC 382)	Electrical machinery (ISIC 383)	Transport equipment (ISIC 354)	Scientific and professional equipment (ISIC 385)	Other machinery (ISIC 390)	Total capital goods
tin America						
1963	2.57	3.45	7.35	2.19	0.33	15.89
1967	3.12	4.25	6.62	1.83	0.42	16.23
1970	4.58	3.79	6.21	1.53	0.46	16.53
1975	7.07	4.31	6.65	2.75	0.39	21.17
1977	7.30	4.76	6.06	2.77	0.42	21.32
1979	7.39	5.10	5.82	2.91	0.38	21.61
opical Africa						
1963	0.22	1.06	7.37	0.42	0.81	9.88
1967	0.24	1.40	4.89	0.34	0.97	7.82
1970	0.19	1.54	4.06	0.30	0.83	6.93
1975	0.15	1.77	3.66	0.29	0.83	6.70
1977	0.14	1.73	3.56	0.36	0.89	6.68
1979	0.13	1.77	3.56	0.24	0.67	6.37
rth Africa iddle East						
1963	2.15	2.31	4.51	0.03	0.42	9.41
1967	1.68	1.99	3.46	0.03	0.75	7.91
1970	1.81	2.09	4.02	0.04	0.67	8.62
1975	2.17	2.17	3.63	0.02	0.61	8.60
1977	1.77	3.77	3.12	0.02	0.49	9.16
1979	2.00	2.19	3.35	0.02	1.21	8.77
uth Asia						
1963	4.91	3.09	8.65	1.33	0.0	17.98
1967	6.04	3.67	9.33	0.59	1.04	20.67
1970	5.80	4.14	9.20	0.60	1.20	20.94
1975	5.73	4.34	5.95	0.55	0.50	17.07
1977	5.84	4.21	5.41	0.60	0.50	16.57
1979	2.36	4.98	2.64	0.18	0.71	10.87
st Asia						
1963	1.97	2.22	3.59	1.31	2.95	12.04
1967	2.46	3.40	3.65	0.67	2.55	12.72
1970	1.91	4.29	3.27	0.75	3.67	13.89
1975	2.75	7.27	3.82	1.10	2.55	17.49
1977	2.88	8.84	4.30	1.44	2.74	20.19
1979	3.59	10.35	4.65	1.68	2.57	22.85

Source: UNIDO data base; information supplied by the Statistical Office of he United Nations with estimates by the UNIDO secretariat.

Note: Totals may not add precisely because of rounding.

Table 17. Share of production in apparent consumption by type of capital goods in selected years
(Percentages based on 1975 dollar prices)

Region and year	Non-electrical machinery (ISIC 382)	Electrical machinery (ISIC 383)	Transport equipment (ISIC 354)	Scientific and professional equipment (ISIC 385)	Total capital goods
Latin America					
1970	0.393	0.687	0.691	0.817	0.774
1975	0.509	0.724	0.720	0.881	0.812
1977	0.352	0.824	0.802	0.925	0.748
Tropical Africa					
1970	0.098	0.288	0.102	0.105	0.150
1975	0.102	0.260	0.080	0.129	0.130
1977	0.106	0.289	0.209	0.114	0.212
North Africa -Middle East					
1970	0.063	0.211	0.209	0.033	0.156
1975	0.051	0.212	0.122	0.019	0.115
1977	0.084	0.247	0.205	0.024	0.173
South Asia					
1970	0.606	0.840	0.728	0.691	0.729
1975	0.699	0.861	0.704	0.812	0.767
1977	0.798	0.919	0.854	0.858	0.872
East Asia					
1970	0.134	0.561	0.412	0.220	0.382
1975	0.202	0.750	0.459	0.522	0.495
1977	0.354	0.888	0.665	0.721	0.738
South					
1970	0.307	0.584	0.518	0.654	0.571
1975	0.333	0.589	0.424	0.736	0.526
1977	0.324	0.698	0.590	0.814	0.608

added in the South as a whole and in the separate regions thereof. In the South as a whole the share is rising in all branches of capital goods except ISIC 390 (other machinery), which may not be a reliable index because of the residual nature of this category and hence its vulnerability to arbitrary changes in definitions of the other sectors. Even among the regions whose capital goods sectors have been growing rapidly, including East Asia, Latin America and the North Africa-Middle East region, there have been some fairly substantial differences. For example, non-electrical machinery has experienced the sharpest rise in Latin America and South Asia, but grown only very slightly from a low base in East Asia and even fallen in Tropical Africa. Electrical machinery has accounted for much of East Asian growth, grown rapidly in North Africa and the Middle East, and obtained an increasing share of manufacturing value added in Tropical Africa, but increased little in Latin America. Likewise, the performance of the transport equipment sector has varied considerably from region to region, increasing sharply in Latin America and the North Africa-Middle East region, remaining nearly constant in East Asia and declining in South Asia and Tropical Africa. Moreover, because of variations in productivity, trends in the manufacturing employment share of individual capital goods may be the reverse of value-added trends.

Finally, another aspect of structural change is revealed in table 17, in which trade data is related to production data. Specifically, production of each three-digit ISIC category is related to the corresponding value of apparent consumption, defined as gross production plus imports less exports in each of the four main capital goods subsectors and in the capital goods sector as a whole. While in the South the overall share of production in apparent consumption has been rising relatively consistently in the capital goods sector, there are some significant differences from one region to another. In South Asia the ratios of production to apparent consumption have been rising for all capital goods, though generally at a slower rate than in East Asia, which has experienced rapid increases. In the other regions, growth in these ratios has been limited to certain types of capital goods, while remaining virtually imperceptible at the aggregate level. In all regions of the South, except North Africa and the Middle East, the ratio of production to apparent consumption in non-electrical machinery remains well below that of other capital goods.

Summary

By way of conclusion, and to present a clearer picture of the implications of the statistical data contained in this paper, a summary of its main points is given below.

1. Static allocative efficiency criteria and especially factor proportions are less relevant to the determination of efficient production and trade patterns in capital goods industries than in other industries.

2. The factor requirements of capital goods industries are not, however, beyond the capabilities of developing countries as a whole. Because several categories of capital goods have relatively high requirements of skills which are available and fairly cheap only in certain regions of the South, and others have similar requirements of capital which is available and cheap only in certain other regions, substantially more capital goods production in the South would be feasible and economic through an effective programme of South-South co-operation.

3. The importance of dynamic aspects of efficiency and in particular of learning-by-doing in capital goods industries justifies the high priority given to capital goods production in the South.

4. Another advantage of southern capital goods production is the provision of technology that is more appropriate and efficient in both factor proportions and scale to the conditions prevailing in the various countries and regions of the South.

5. There is considerable evidence that, compared with northern capital goods producers, developing countries are able efficiently to produce capital goods with considerably greater labour-intensity and on a smaller scale than generally assumed. This capability of the South can often be developed relatively quickly and inexpensively by importing the necessary machinery and then producing older lines of northern capital goods.

6. It should be possible to overcome most of the obstacles to southern production of capital goods through a judicious allocation of responsibilities among the regions concerned, and in particular by relying on multinational joint ventures of developing countries as the institutional vehicle. The one obstacle that is likely to remain insurmountable in the foreseeable future is the requirement of rapidity of new product development characteristic of some capital goods subsectors. This would seem to rule out, or at least to suggest that relatively low priority should be given to, the professional and scientific machinery and miscellaneous capital goods subsectors in southern production and South-South co-operation.

7. On the one hand, the potential for southern production through South-South trade could be seriously overestimated because of the total value of southern imports from the North. On the other hand, that potential could be seriously underestimated in the calculations of Yeats [10], who considers only labour-intensive capital goods and takes exports to the North as a decisive factor.

8. In assessing the potential for increased production and export of capital goods in the South, it is important to focus on those subsectors in which the South has in recent years achieved relatively high rates of growth in both production and exports, as has been the case in virtually all capital goods subsectors, particularly those of non-electrical machinery, electrical machinery and transport equipment. Within these subsectors, promising lines of development for the South would seem to be power-generating machinery (SITC 711), agricultural machinery (SITC 712), office machinery (SITC 714), metalworking machinery (SITC 715), textiles and leather machinery (SITC 717), other specialized non-electrical machinery (SITC 718 and 719), electric-power generating machinery (SITC 727), miscellaneous electrical machinery (SITC 729), railway vehicles (SITC 731), road motor vehicles (SITC 732) and ships and boats (SITC 735).

9. It is extremely difficult to translate the above considerations into a precise estimate of the additional amount of production and trade in capital goods that might be obtained through the envisioned programme of South-South co-operation involving the creation of a southern capital goods company that would be treated as a partly or wholly domestic enterprise in all or most regions of the South. Nevertheless, since capital goods industries are regarded as the logical focus for South-South co-operation, it is important to make the attempt. Should an effective

programme of South-South co-operation be established, it would seem reasonable to expect that rather high growth rates of value added and exports to the South could be maintained until 1990. Without such co-operation, however, further import substitution and export expansion in capital goods will be problematic, and growth rates of production and exports between 1975 and 1990 may prove to be considerably lower than in the recent past.

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